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DISEASES AND INJURIES
OF THE TEETH

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INCLUDING

PATHOLOGY AND TREATMENT

BY

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DENTAL SURGEON TO CHARING CROSS HOSPITAL, AND TO THE DENTAL HOSPITAL OF LONDON

Second Edition. Revised and Enlarged

BY

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LONGMANS, GREEN AND CO.

39 PATERNOSTER ROW, LONDON

NEW YORK AND BOMBAY

1901

JOHN BALE SONS and DANIELSSON Ltd
Gt TITCHFIELD STREET
LONDON

PREFACE TO THE SECOND EDITION.

In preparing this Edition the work has been almost entirely rewritten and considerably extended.

A few alterations have been made in the grouping of the different dental affections. The condition hitherto termed "dilaceration" has been included in the chapter on "Injuries of the Teeth," and has been considered under the heading of "dislocation of unerupted teeth."

In the chapter on "Diseases of the Periodontal Membrane," several important alterations in the nomenclature have been made:— The terms "exostosis" and "absorption" have been replaced by "productive periodontitis" and "rarefying periodontitis." The latter terms are more expressive of the actual conditions and are more in keeping with modern pathology. The term "pyorrhœa alveolaris" has been abandoned, and the affection described under the heading of "acute and chronic suppurative periodontitis," terms which more accurately denote the nature of the condition. Throughout the work, the term "premolar" has been substituted for "bicuspid" and the terms maxilla and mandible adopted.

A chapter on the "Bacteriology of the Mouth," written by Mr. Kenneth Goadby, has been added. This chapter, like all dental pathology, cannot be intelligently understood unless the student has mastered, as he should have done, the principles of general pathology.

The chapter on "Abnormalities in Position of the Teeth" has been considerably enlarged, and many new illustrations added.

To Dr. Miller of Berlin and Mr. Howard Mummery, who have kindly revised the chapter on "Caries," and suggested many alterations and additions, I must tender my thanks.

I also desire to express my gratitude to Dr. Leon Williams for

the photo-micrographs and woodcuts which have been used in illustrating caries in enamel.

A large number of entirely new illustrations appear in this edition, and Mr. L. Danielsson deserves much credit for the care he has bestowed upon the production of the " blocks."

For the loan of blocks I am indebted to the Council of the Odontological Society of Great Britain; the Publishing Committee of the *Journal of the British Dental Association;* Messrs. C. Ash and Sons ; The Dental Manufacturing Co. ; Messrs. S. S. White and Co. ; the publishers of the " American Text Book of Operative Dentistry " and the " American Text Book of Prosthetic Dentistry;" the publishers of " Richardson's Mechanical Dentistry ;" and to Messrs. Churchill and Sons.

I am greatly obliged to Mr. McKay, Mr. J. G. Turner, Mr. Hopewell Smith and Mr. Henry Bale for much kind help, and to Mr. H. Darby for the assistance which he has rendered to me during the passage of the book through the press.

J. F. COLYER.

August, 1901.

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DISEASES AND INJURIES OF THE TEETH.

CHAPTER I.

The First Dentition.

The first or deciduous dentition is composed of twenty teeth, equally divided between the maxilla and the mandible. Named from the median line they are—central incisor, lateral incisor, canine, first molar, second molar.

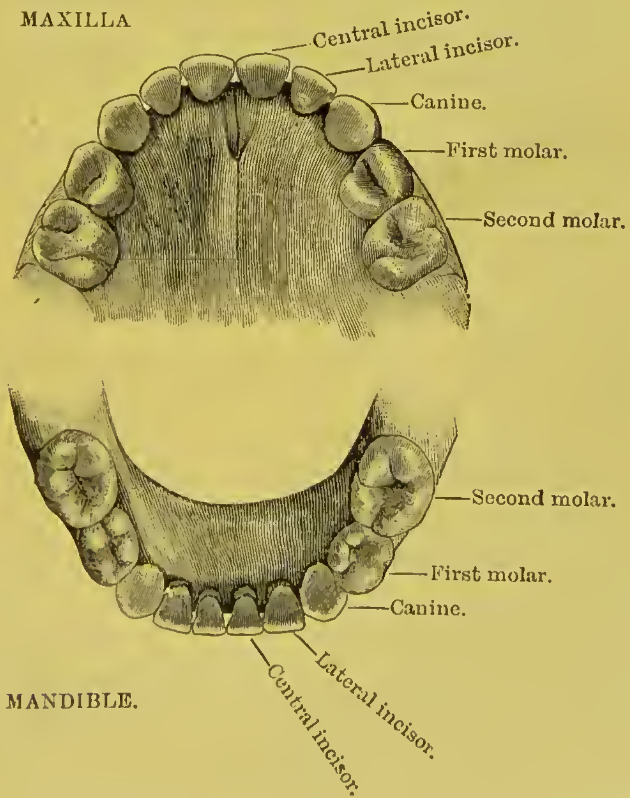

Fig. 1.—Represents a fully-developed set of deciduous teeth.

The dates at which the germs of the deciduous teeth are formed, and the periods at which calcification commences are as follows:—

The enamel organs of the central, lateral, canine, first and second molars, appear in succession during the seventh week of fœtal life, their respective dentine bulbs during the ninth week. The calcification of the central and lateral incisors and canines commences at the seventeenth week of embryonic life, of the first and second molars a week later; the gradual calcification of these is well shown in fig. 2. These dates are only approximate, and are probably considerably influenced by various constitutional conditions of the mother.

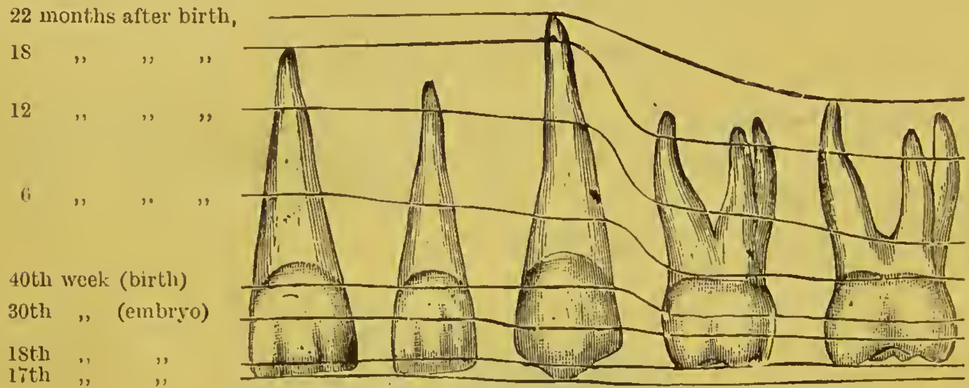

FIG. 2.—From "The American System of Dental Surgery" (Peirce).

(A) NORMAL DENTITION.

(1) **Signs of eruption.**—The normal signs of approaching eruption are an increased flow of saliva and a tendency on the part of the child to bite at any tangible object. The mouth is generally hot, the gums tumid, tense and shining, and the position of the tooth marked by a prominence of gum. The gum is gradually absorbed, and the tooth makes its appearance. To local signs may be added slight irritability, restlessness, and a rise of temperature which is usually higher in the morning than in the evening. Many healthy children pass through this period without any untoward symptoms, in others morbid lesions appear. The tables of mortality show that over 4 per cent. of the deaths in children under twelve months, and about 7 per cent. in those between the ages of one and three years, are ascribed to "teething." It is more than probable that these figures are an exaggeration. Thorough *post-mortem* examination and more care in filling in death certificates would reduce the figures of mortality from teething to smaller and truer proportions.

(2) **Periods of eruption.**—Reliable statistics are wanting as to dates of eruption of the various teeth composing the deciduous dentition. The following are given by Dr. White (*Cosmos*, November, 1890):—

Central incisors ...	...	...	...	5th to 8th month.
Lateral incisors...	...	...	...	7th to 10th ,,
First molars ...	...	...	...	12th to 14th ,,
Canines ...	...	...	...	14th to 20th ,,
Second molars ...	...	...	...	20th to 30th ,,

The mandibular teeth usually erupt before the maxillary. The teeth as a rule erupt in pairs or groups, and between the eruption of the different pairs there is an interval varying from two to five months, the period being greater between the last groups. Early eruption would seem to be a sign of weakness rather than of strength.

The period of dentition is in some ways analogous to other "critical periods," such as utero-gestation, the commencement and cessation of the menstrual function. At these times there is apparently increased nervo-vascular action which easily passes from a physiological to a pathological condition. In the case of eruption the pause between the individual groups would appear to be a beneficial arrangement as it allows the child to recuperate the nervous energy expended in the process. Mr. Coleman[1] records a case "of a male child who, having lost its mother at birth, did fairly well up to the usual period of teething, when tooth after tooth, irrespective of group, rapidly made its appearance . . . . and the child gradually lost strength from day to day, and week to week, until it finally sank exhausted."

(B) THE PROCESS OF ERUPTION.

No satisfactory explanation has yet been advanced to account for the mechanism of eruption. **The oldest and simplest theory** accounts for the process by the **elongation of the roots of the teeth.** This theory implies that as fresh dentine is added to the base of the root the crown is thrust forward, the pressure thus brought to bear on the overlying structures causing their absorption and so allowing the tooth to erupt. Against this theory the following arguments are advanced:—

(i.) Teeth with stunted roots occasionally erupt.

[1] "Dental Surgery," p. 9.

(ii.) The distance the crown of a tooth travels in the process of eruption is often much greater than the depth of tissue which is added to its root during the same period.

(iii.) Teeth with fully formed roots may remain buried during the whole lifetime of the individual, or may only erupt late in life.

With regard to this last argument it must not be forgotten that the crown of the tooth may have become misplaced in its direction, and the addition to the root might simply force it further in its abnormal position.

A second view is that the deposition of bone in the crypt gradually forces the tooth upwards. This is only a modification of the "elongation of root" theory.

A third view likens the process to that which takes place in the sharks and rays. In these fish, the mucous membrane in which the teeth are developed and to which they are attached gradually grows and brings successional rows of teeth to the margins of the jaws, the older being eventually lost. Mr. Coleman advanced this theory in a paper contained in the *St. Bartholomew's Hospital Reports*, 1867 (p. 91), and it received the support of Prof. Owen, who pointed out that a similarity of idea had occurred to him, and was referred to in his "Odontography" (p. 639).

Mr. Constant[1] considers that the active mechanical factor in the process is the blood pressure exerted in the vascular tissue which lies between the developing tooth and its bony surroundings. The blood pressure, which acts equally in all directions, makes room for the developing root by forcing it in the direction of least resistance, which normally is the direction of the advancing crown.

All that can be safely said at present on the subject is that the tissues overlying the tooth are removed by phagocytes, and that the stimulus leading to the presence of these cells is the presence of the erupting tooth, which is impelled forward by a force the origin of which cannot, with our present knowledge, be satisfactorily accounted for.

(C) PATHOLOGICAL DENTITION.

(1) **Constitutional conditions affecting eruption.**—In children the subjects of hereditary syphilis the teeth often erupt early, and it is by no means uncommon to find one or two teeth present at

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[1] *Journal of the British Dental Association*, vol. xvii., p. 729.

birth. These teeth usually soon fall out owing to want of development of the root and alveolar process. If the teeth are normal in shape and firmly implanted they should be retained, an indiarubber guard being used to protect the nipple. In **rachitis** eruption is delayed. The delay is usually regarded as an important sign of this affection. The retarded eruption is attributed, by some, to thickening of the tooth sac. The formation of fibrous odontomes in rickety animals supports this view (see p. 500).

(2) **Diseases incident to the first dentition.**—In weakly infants the process of teething may give rise to local and general disturbances.

(*a*) *Local.* **Simple stomatitis.**—The stomatitis is usually limited to the gums. It is characterised by intense redness and swelling, the mouth at the same time being hot, the child fractious, restless and in evident pain, which is increased on the patient being placed in a horizontal position. The temperature may reach 104° F. or 105° F., but it should be remembered that pyrexia in children readily supervenes upon slight causes.

Ulcerative Stomatitis. — In these cases the gums become extremely hot, swollen, and painful, which is especially marked over a certain tooth, giving the appearance of a little tumour. Ulceration supervenes, and may extend to the gum around any other tooth already erupted; the ulcers thus formed have a sloughy appearance. The breath is fœtid and hot, the flow of saliva is increased and the child rejects its food. In addition there is marked pyrexia and, at times, gastro-intestinal disturbance.

Phagedænic Stomatitis.—This occurs in children suffering from an exanthematous fever. The gums over the erupting tooth or teeth inflame and slough, a condition which, unless arrested, rapidly spreads.

Treatment.—The first of these local conditions is best treated by the administration of a brisk purge, which will generally relieve the local symptoms, and the gums can be scarified by giving the child a hard substance to bite on, such as a lump of sugar. Should the symptoms persist, it is better to remove the tension at once by free incisions. The second is best treated by local applications, and by the internal administration of chlorate of potash, care being taken that the bowels are freely relieved. The symptoms generally yield to this treatment. The third condition is relieved by touching the ulcer with some escharotic, such as pure phenol.

(*b*) *General.*—During the period of teething children seem to be susceptible to general disturbances. With some practitioners there is a tendency to underestimate teething as a disturbing element, while others seem only too ready to ascribe to it all the ills to which children are liable at this age. The discussion of this question falls more within the scope of works devoted to medicine. It may, however, be useful to direct attention to a few points which should not be lost sight of in endeavouring to trace the true relationship between teething and systemic conditions. The process of teething, as before stated (p. 3), is to be regarded as one of the critical periods of life, and like other critical periods is accompanied by an increased irritability of the nervous system, and a lowering of resistance on the part of the individual, with, consequently, a liability to develop a pathological condition in a part naturally weak. In this way it is possible to explain some of the general disturbances met with at this period. For example, the pathological conditions arising in the respiratory and intestinal tracts would, perhaps, be more correctly attributed to direct causes acting on tissues lowered in vitality than to reflex irritation from the teeth. In some instances, however, the general lesion is traceable to distinct reflex irritation from erupting teeth. In an infant the brain and spinal system are predominant, and slight peripheral irritation is liable to cause a general disturbance; for, just as a convulsive seizure may result from gastric irritation, so the irritation from an erupting tooth may start a more general disturbance. The following case quoted by Mr. Tomes[1] is of value in this connection. A child, while playing, suddenly fell down in a state of insensibility. A practitioner was called in, who, on examining the mouth, found that the gum was raised and in a state of tension over a deciduous molar. An incision was made down to the tooth, the child immediately recovered its sensibility, and in a few hours was perfectly well.

The irritation in the mouth, in most instances, is due to direct pressure of the tooth upon the superincumbent tissue, as evidenced by local inflammation. Dr. White, however, points out that the irritation may arise in another and more obscure manner. The aperture at the end of the growing root is large, and the pulp tissue is in a condition of irritation from the activity of the process of

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[1] "System of Dental Surgery," fourth edition, p. 23.

dentition. If the irritation be augmented, the hyperæmia produced would be sufficient to cause the pulp to protrude from the incomplete aperture of the root, and, owing to undue resistance of the gum tissue, reflex irritation would result from the pressure. Dr. White supports his view by clinical evidence afforded by cases in which there are no local signs of inflammation or irritation, and in which constitutional disturbance disappears on lancing the gum.

The disturbances to which children seem prone at this period may be grouped as follows :—

(i.) **Affections of the nervous system.**—Sleeplessness, irritability, muscular twitchings, convulsions.

(ii.) **Affections of the respiratory tract.**—Laryngeal cough and bronchitis.

(iii.) **Affections of the alimentary tract.** — Diarrhœa and vomiting.

(iv.) **Affections of the skin.** — Erythema, eczema, herpes, impetigo.

(v.) **Affections of the genito-urinary tract.** — Increased or diminished secretion of urine occurs. In one instance recorded by John Hunter there was a discharge from the penis resembling a violent gonorrhœa. The discharge always recurred with the eruption of the teeth.

Treatment.—The treatment of these conditions lies within the province of the general practitioner. In cases of convulsive seizure, and even in some other cases, the dental surgeon may be called in consultation with a view to lancing the gums. It should, therefore, be remembered that convulsions may arise from causes other than dental irritation, one of the most common being gastro-intestinal irritation. If no other cause can be found, the operation of lancing the gums should be performed, even if inflammation is absent. "A curved bistoury should be used, and in order to prevent injury to surrounding parts a strip of lint should be wrapped round the knife so that only half an inch is exposed. The technique of the operation is quite simple. The child should be placed on a pillow on the lap of the nurse, who should be seated on a chair opposite the operator and with her back towards the source of light which should come preferably from a north window. The operator should seat himself facing the nurse with the end of the pillow supporting the child's head in his lap. He then can command the territory

of operation, and, by holding the child's head, guard against any sudden movement. The hands and the body of the child are to be firmly held by the assistant. The lancet is then passed through the overlying tissue until it is felt to come into contact with the enamel surface, and the tissue divided sufficiently to allow the tooth to erupt without resistance" (Kirk). The best method is to make two semi-lunar incisions which meet at their extremities, and remove the intervening portion of gum with a pair of tenaculum forceps. Objection is raised to the use of the lancet when the tooth is still some distance from the surface, on the ground that the cicatricial tissue offers a greater bar to the progress of the tooth. This objection is untenable, as cicatricial tissue is of a lower degree of organisation than normal fibrous tissue, and, therefore, more easily disintegrated by pressure.

With regard to affections other than convulsions, the dental surgeon, if called in consultation, should hesitate to attribute the condition to dental irritation until he has eliminated all other causes. It is well to bear in mind that the affections that arise from nervous irritation, such as laryngeal cough, are more likely to be due to reflex dental irritation than conditions like diarrhœa and vomiting, which are generally traceable to errors in diet.

CHAPTER II.

Second Dentition.

(A) NORMAL DENTITION.

When complete the permanent dentition numbers thirty-two teeth. In the half of the maxilla and mandible, respectively, will be found a central incisor, a lateral incisor, a canine, a first and second premolar, and three molars, the first five teeth having replaced deciduous teeth, the molars having had no predecessors.

(1) **Absorption of the deciduous teeth.**—The processes by which the roots of the deciduous teeth are removed have been dealt with by several authors, who have advanced the following theories to explain the phenomenon.

(*a*) That it is caused by the pressure of the crown of the permanent tooth on the root of its deciduous predecessor.

(*b*) That it is due to the presence of an absorbent organ consisting of a mass of large multi-nucleated cells. If a deciduous tooth, which has undergone absorption, be examined, the root will appear excavated in a cup-shaped manner, the loss of tissue being at or near the apex, and in fortunate specimens a soft vascular substance—the so-called **absorbent organ**—will be found in contact with the tooth. A section of such a tooth examined microscopically will show, at the part attacked by absorption, well-marked Howship's lacunæ, and if the section has been prepared by a method in which hard and soft tissues can be cut together, it will be seen that the soft vascular part is composed of a mass of cells, those nearest to the dentine being multi-nucleated and fitting into the cup-shaped excavations in the dentine. Fig. 4 is a drawing of the absorbent cells in contact with the dentine. It will thus be seen that the so-called absorbent organ is only a mass of cells, some of which act as osteoclasts. In absorption of the permanent teeth, a typical example is the pressure of the mandibular third molar upon the posterior root of the second mandibular molar. A section through the absorbed portion will show exactly the same condition

as may be observed in an absorbed deciduous tooth. In specimens of rarifying periodontitis, Howship's lacunæ filled with the characteristic giant cells can be seen. The disappearance of the tooth

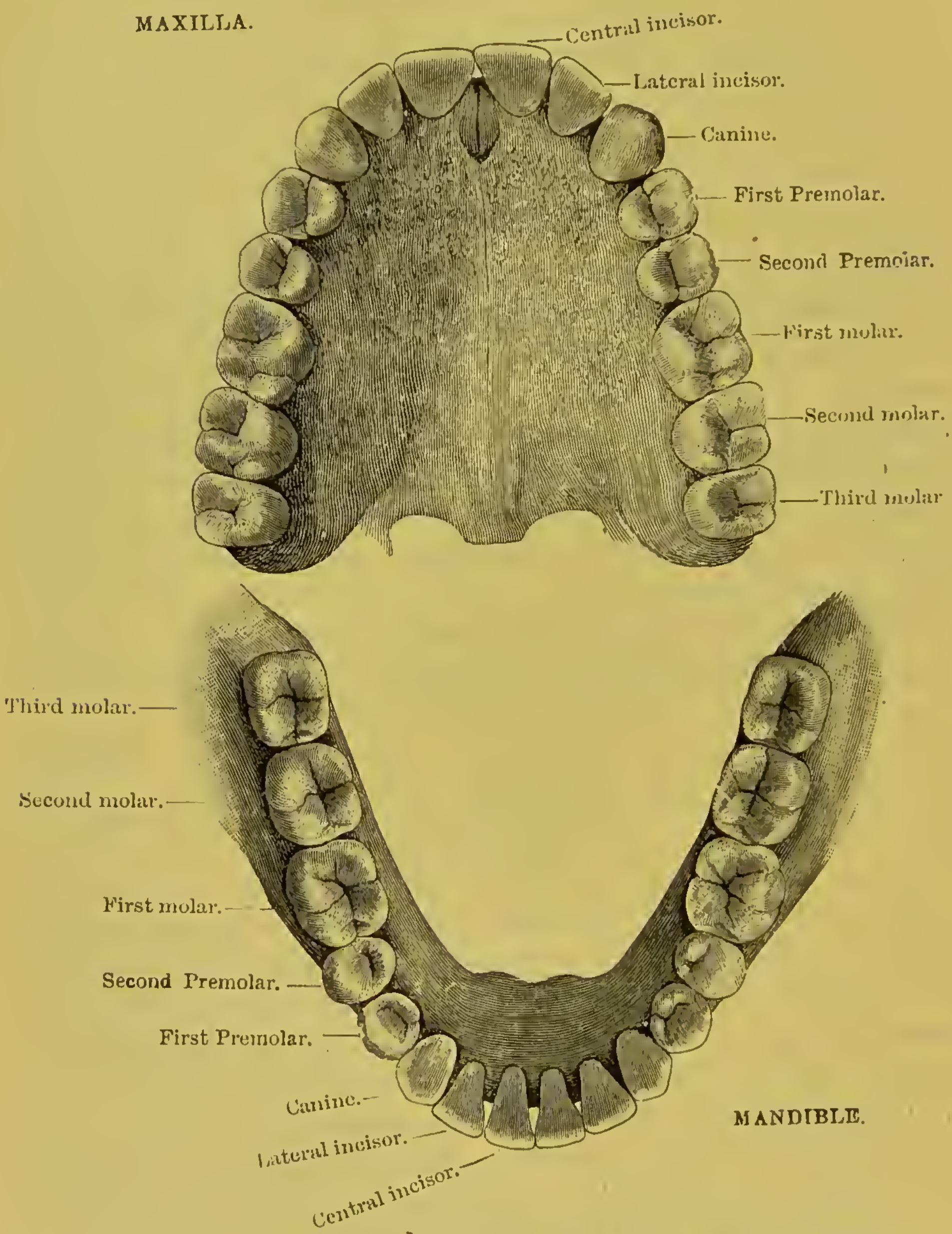

FIG. 3.—Represents a fully developed set of permanent teeth.

tissue of the deciduous tooth undoubtedly depends upon the presence of these multi-nucleated or osteoclastic cells. How they perform their work is not quite clear. Some have advanced the theory that they send out amœbiform process, others that they secrete an

acid and thus dissolve the tooth substance, the remaining organic substance being removed by phagocytic action. What determines the presence of the so-called absorbent organ is yet unknown. Whether it is due to the presence of and pressure from the perma-

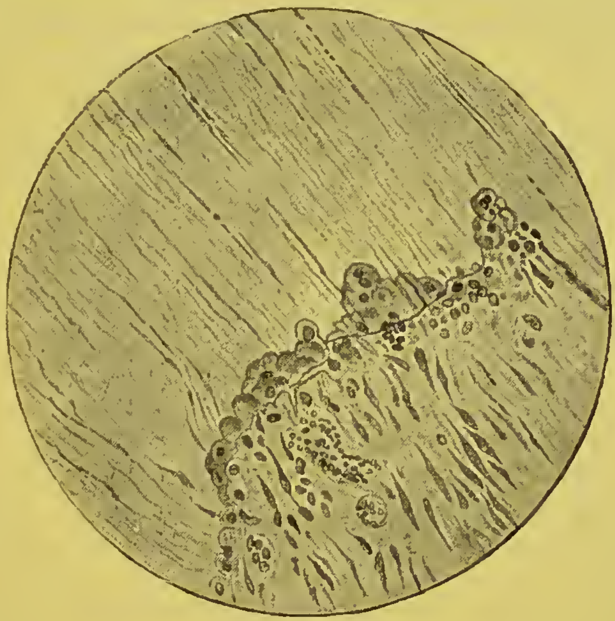

FIG. 4.[1]

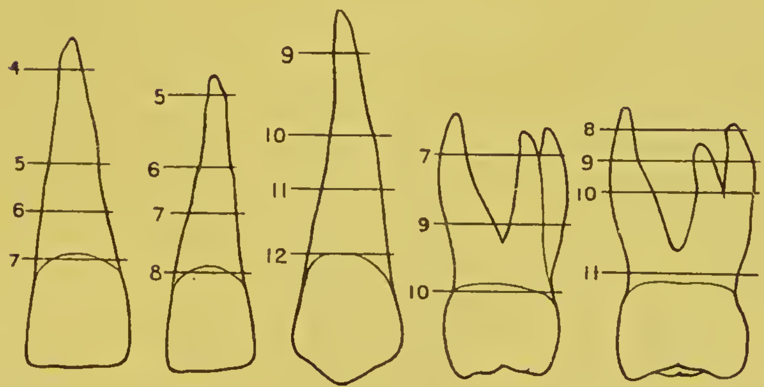

FIG. 5.

(The figures indicate years.)

nent teeth or to some other agency is a problem which still awaits solution. In deciduous teeth containing septic pulps the process of absorption seems to take place slowly, and in some instances not at all.

[1] From a drawing by Mr. J. Howard Mummery.

The following diagram shows the decalcification of the deciduous teeth at various ages.

(2) **Dates of eruption.**—The following table is given by Dr. Dietlein.[1] The figures are based on the examination of about 7,500 persons, ranging in age from 6 to 60 years.

	Name of the Tooth	Period of Eruption	
		Years	Months
Maxilla	Incisor I.	7	10
	Incisor II.	8	9
	Canine	11	9
	Premolar I.	10	2
	Premolar II.	11	3
	Molar I.	7	5
	Molar II.	12	10
	Molar III.	24	—
Mandible	Incisor I.	7	4
	Incisor II.	8	3
	Canine	10	9
	Premolar I.	10	10
	Premolar II.	11	4
	Molar I.	7	—
	Molar II.	12	4
	Molar III.	24	—

It will be noticed that :—

(*a*) The mandibular incisors appear six months earlier than the corresponding maxillary teeth.

(*b*) The mandibular canine is erupted nearly one year before the maxillary canine, and both appear at an earlier age than is given in the older tables.

[1] *Oesterreich Ungarische Vierteljahrsschrift.* Translated in *Ash's Quarterly Circular.*

(*c*) The first maxillary premolar appears eight months before the mandibular premolar, the latter erupting practically at the same time as the canine.

(*d*) The second premolars, maxillary and mandibular, appear at nearly the same period.

(*e*) The mandibular first and second molars precede the maxillary teeth by about six months.

In the different classes of society the teeth seem to erupt at varying periods, the period being latest in the working classes and earliest in the leisured classes. The following figures from Dietlein illustrate this :—

	Name of the Tooth	Period of Eruption. Table A. Years	Table A. Months	Table B. Years	Table B. Months
Maxilla	Incisor I.	8	—	7	3
	Incisor II.	9	—	7	11
	Canine...	11	3	11	6
	Premolar I.	10	3	9	11
	Premolar II.	11	3	11	—
	Molar I.	7	6	6	9
	Molar II.	12	6	12	10
Mandible	Incisor I.	7	6	6	7
	Incisor II.	8	4	7	7
	Canine...	10	7	10	2
	Premolar I.	10	6	10	6
	Premolar II.	11	2	11	2
	Molar I.	7	3	6	9
	Molar II.	12	2	12	4

Table A contains the results of an investigation of 1,300 girls in the National Schools of Freiburg.

Table B contains the results of an investigation of 800 children from the higher girls' school.

Certain teeth erupt at an earlier age in the female than in the male. The second molar and canine are examples, the former averages six months and the latter nine months earlier in the female than in the male.

The eruption of the third molars depends, to a great extent, upon the amount of space in the arch. With all the teeth present the figures given in the above tables probably represent the average age of appearance. The early removal of second molars will accelerate the appearance of the third molars, which may erupt as early as the fifteenth year, and the same may occur after early removal of the first molars.

The calcification of the teeth at different ages is shown in the diagram (fig. 6).

(B) ABNORMAL DENTITION.

The eruption of the permanent teeth is retarded by rachitis. A case of retarded dentition in a female, aged 14, is shown in figs. 7 to 10. This patient suffered from rickets in infancy. In children of a nervous temperament the teeth often erupt early.

Retardation in the eruption of individual teeth.—In the maxilla the eruption of the canine often takes place as late as 20 to 25 years, and cases are seen in which the canines do not appear until quite late in life. Salter mentions an instance of this tooth first appearing at the age of 70. This retarded eruption of the canine is much more common in females than in males, and in the upper than the lower classes.

The premolars are, at times, retarded in their eruption. In one patient under notice the second right maxillary premolar did not appear until the age of 35. The third permanent molar is frequently retarded and may erupt at any time up to the age of 70. In the mandible the first and second premolars are frequently retarded in their eruption, and the appearance of these teeth may be delayed for two or three years. The second is more frequently retarded in its eruption than the first premolar. The mandibular third molar may erupt at any time after puberty.

The **causes which may give rise to these conditions** are various, and, perhaps, one of the commonest is obstruction due to **crowding.** This is well seen in cases of the arrested eruption of the third

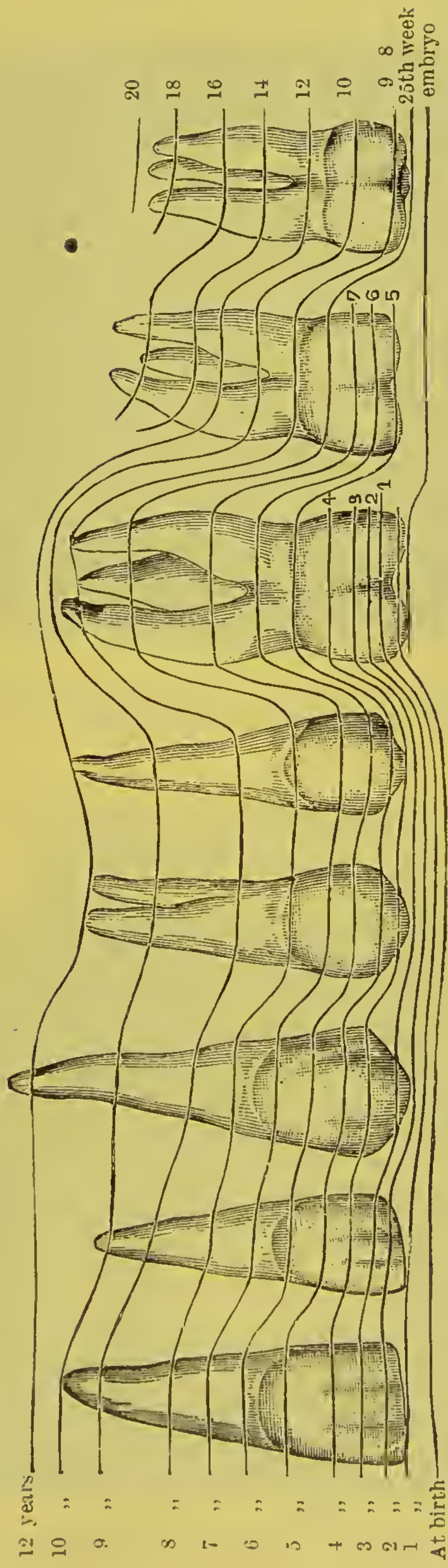

FIG. 6.—From "The American System of Dental Surgery."

Fig. 7.—Model of maxillary teeth. The only teeth of the permanent series erupted are the first molars. A conical shaped supernumerary tooth is present between the deciduous central incisors.

Fig. 8.—Model of mandibular teeth. The only teeth of the permanent series present are the first molars.

molars and maxillary canines. Geminated deciduous teeth may act as impediments, and in one case the mandibular central incisor was prevented from erupting because absorption had taken place only at that part of the root corresponding to the deciduous central incisor,

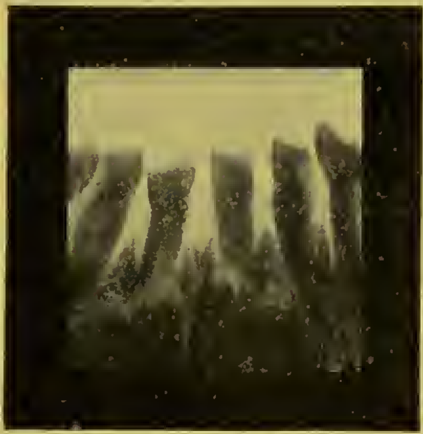

FIG. 9.—Skiagram showing the unerupted mandibular incisors.

FIG. 10.—Skiagram showing the unerupted mandibular premolars.

leaving that portion of the root corresponding to the lateral incisor firmly imbedded and unabsorbed. A deciduous tooth, especially the second molar, may become wedged between its approximal teeth owing to the latter having slightly inclined towards each other. In teeth that are erupted towards middle life the growth is extremely slow, extending over years.

The local disturbances accompanying eruption of the permanent teeth are mainly confined to the third molars, especially the mandibular. Before the cusps are erupted local inflammation may attack the superincumbent tissues, and the signs of inflammation, pain, heat, swelling, and redness, will be present. This condition is best treated by free incisions, or, what is perhaps better, by removing a portion of the overlying gum.

When a molar tooth erupts the anterior cusps appear first, and the small portion of gum which lies over the posterior part of the tooth occasionally ulcerates from constant pressure of the antagonising tooth. The ulceration may become extremely painful and the inflammation spread to adjacent tissues. The patient complains of pain in the region of the fauces, but perhaps the most tender point is where the mucous membrane of the gum becomes continuous with that of the cheek. This is best relieved by free incisions, care being taken that the knife divides all the tissues overlying the buccal surface of the tooth. Should this not bring relief it is advisable to remove the process of gum that is covering the tooth, which can be accomplished with the scalpel and forceps. In addition, fomentation of the mouth inside should be advised, and hot water at a temperature just bearable is perhaps as comforting an application as any, although decoction of poppy-heads is often to be recommended, the opium contained in the poppies acting as a local anodyne. When the ulceration is severe, mouth-washes of chlorate of potash, hazeline, or calendula should be prescribed. Suppuration may supervene, and, if the offending tooth be not removed, trismus may occur. The trismus is said to be produced in most cases by spasm of the masseter muscle, due to reflex irritation, but it is more than probable that it is caused by spread of inflammation to adjacent tissues. The insertion of the temporal and pterygoid muscles and the intervening cellular tissue may, by a process of continuity of inflammation, become affected, and produce closure of the jaws. This explanation seems more in harmony with the clinical aspect of the majority of cases generally met with, for, in nearly all, the patient is able to effect slight movement in the articulation, which would not be possible if the trismus were due to tonic spasm of the masseter muscle. Again, the mobility of the articulation increases as the inflammatory symptoms subside. The above appears to be the correct explanation of the majority of cases, but instances may occur where the closure of the jaw is due

to a clonic spasm of the muscles of mastication. The treatment of the above condition is to remove the erupting tooth. This is carried out as follows. The patient should be anæsthetised and the anæsthesia prolonged, if necessary, by ether. The mouth should be opened by a Mason's gag or an ordinary screw-gag, and the tooth removed with an elevator. Mandibular third molars, when impacted, may give rise to severe odontalgia in the second molar, the pressure from the erupting tooth causing absorption of the posterior surface of the second molar leading to exposure of its pulp. The absorption in these cases is not due to the pressure of the crown of the third molar against the cementum or enamel of the second, but to multi-nucleated cells which are developed at the point of contact, and which perform the function of osteoclasts in removing the obstructing tissues. In these cases the second molar should be removed.

General disturbance accompanying eruption of the permanent teeth.—The most common is severe neuralgia which may be due to pressure upon the main trunk of the mandibular nerve. The pain being situated in the regions of the ear, face and neck, may produce reflex odontalgia in any tooth or teeth on that side of the mouth. Hemicrania, at times, accompanies the eruption of the third molars, while cases of otalgia, epilepsy and paralysis have been traced to this cause. Chorea has been stated to have been caused by reflex action due to difficult eruption, but Dr. Sachs, in Keating's *Cyclopædia of Diseases of Children*, referring to reflex chorea, says, "I feel warranted in saying that there are very few cases of true reflex chorea, and the only cases I have seen which were of indubitable reflex origin were due to intestinal parasites." A still more rare condition is suppuration extending into the deep cervical fascia (*Angina Ludovici*). This condition from the anatomical relations of the cervical fascia may be of great gravity.

CHAPTER III.

Variations of the Teeth in Size, Number and Structure.

(A) VARIATIONS IN SIZE.

Series of teeth vary considerably in size as illustrated by the following figs. (11 and 12).

There is a distinct relationship in the sizes of the individual teeth comprising a series. If a number of fully developed mouths be examined it will be noticed that this relationship is more or less constant. In some cases this relationship is disturbed, one or more teeth being out of proportion with the remainder of the series.

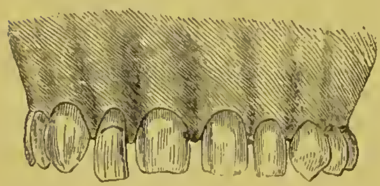

Fig. 11.—(Coleman).

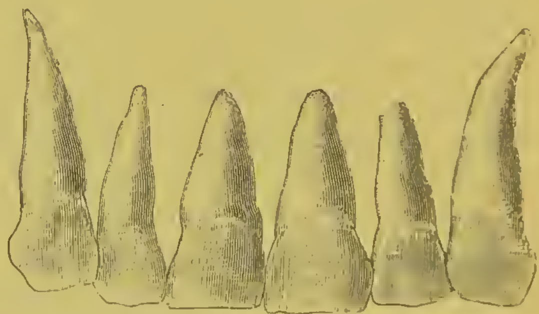

Fig. 12.—From a specimen in the Museum of the Odontological Society.

(1) **Permanent dentition.**—In the permanent series the tooth which is most frequently developed to an **abnormally large** size (fig. 13) is the maxillary central incisor. Such teeth should not be mistaken for a central incisor geminated with a supernumerary incisor. The second mandibular premolar and the second mandibular molar are, occasionally, abnormally large.

Diminution in size is met with mostly in the lateral incisors. These teeth may also be modified in their shape, and in extreme cases are represented by simple cones; occasionally, however, they

may be abnormally large, as is seen in fig. 14. The maxillary third molar, like the lateral incisor, is often dwarfed and modified in its shape (see fig. 15).

(2) **Deciduous dentition.**—The maxillary canine or mandibular molar may be proportionately larger than the other teeth. Such teeth have no particular interest unless they persist, in which case it is sometimes difficult to distinguish them from the permanent teeth. If, however, care is taken in the examination of the mouth and the history of former extractions is ascertained, no error is likely to arise. A deciduous canine can generally be distinguished from a permanent one by :—

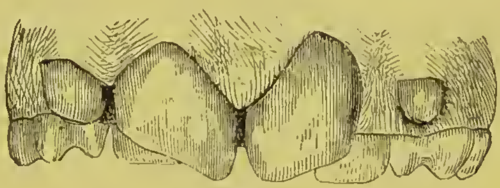

FIG. 13.

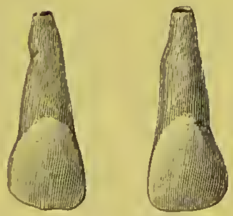

FIG. 14.

FIG. 15.
A small maxillary third molar.

(i.) The abrupt termination of the enamel at its neck.

(ii.) Its having undergone some attrition of the cutting edge.

(iii.) Its appearing smaller, in proportion, than the permanent teeth.

(iv.) The enamel, which is usually translucent.

A second mandibular deciduous molar may be distinguished from a permanent one by :—

(i.) The abrupt termination of the enamel at its neck.

(ii.) The absence of the second premolar.

It will, also, be generally found wedged between the first premolar and the first permanent molar, and on a lower level than either of the teeth between which it is wedged.

(B) VARIATIONS IN NUMBER.

(1) **Permanent dentition.**—Variations from the normal number of teeth may be classified :—

(*a*) Excess in number.

(*b*) Deficiency in number.

(*a*) **Excess in number.**—Any tooth in addition to the normal number is known as a supernumerary tooth. Supernumerary teeth may be divided into two distinct groups :—

First. Those resembling normal teeth in shape and character.

Second. Those abnormal in form.

Fig. 16.—Showing two supernumerary incisors.

In the first class, normal in shape, the tooth usually resembles a lateral incisor, less frequently a premolar, rarely a molar, and, in very exceptional cases, a canine. These teeth, as a rule, are found in the neighbourhood of the tooth they simulate. More commonly they occur in the maxillary lateral incisor region, but an extra incisor or incisors in the mandible are by no means rare. In the maxillary incisor region they are generally either larger or smaller than those in the normal position ; the condition is often symmetrical (fig. 16).

An extra incisor is often seen in cases of cleft palate, the extra tooth being situated on the mesial side of the cleft. The usual

arrangement of the teeth in cleft palate cases is, starting from the median line, central incisor, cleft, badly-formed tooth, canine. The badly-formed tooth is always situated in front of the canine, and has been termed the pre-canine. It is the representative of an incisor. When a third tooth is present it is often well formed and situated on the mesial side of the cleft (see figs. 17, 18).

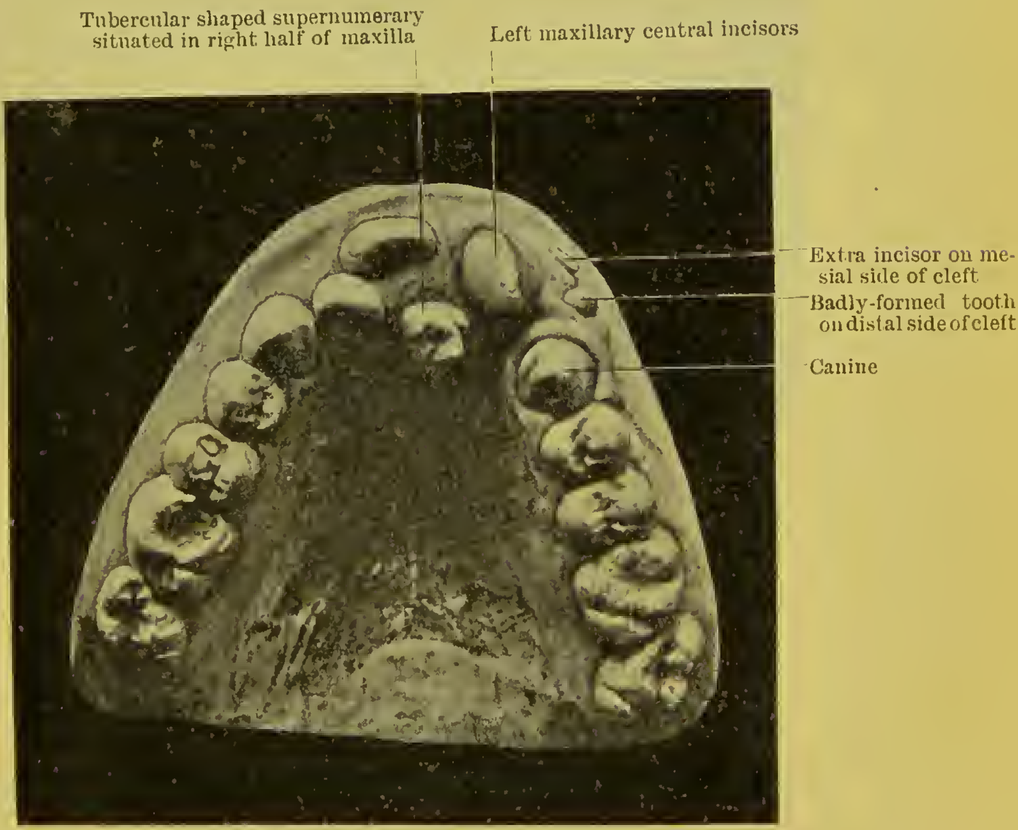

Fig. 17.

In the premolar region two additional teeth are occasionally met with, and in a remarkable case (fig. 20) which occurred in the practice of Mr. C. Handley, there were no less than six premolar teeth on one side, in addition to two other supernumerary teeth. A model showing five mandibular premolars on one side was exhibited by Mr. P. Linnell at the annual meeting of the British Dental Association held in Manchester, 1892.

In the molar region the additional tooth is usually to be found

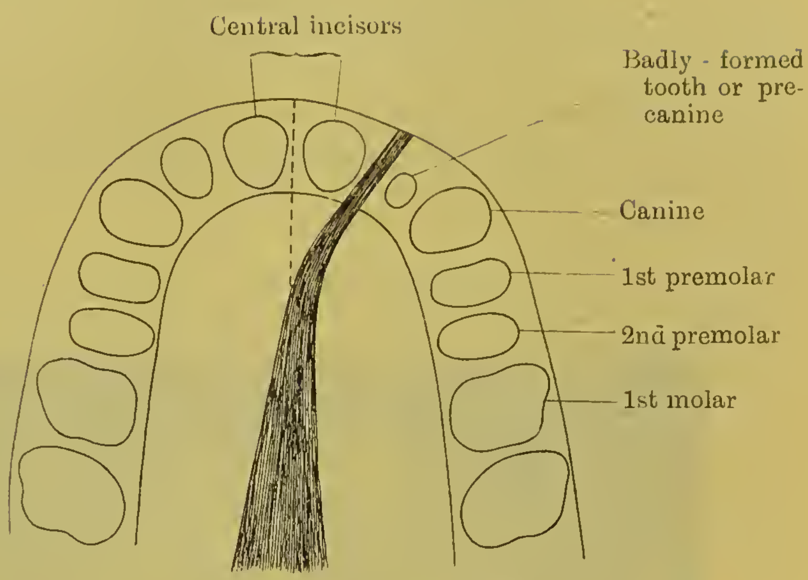

Fig. 18.—Usual arrangement.

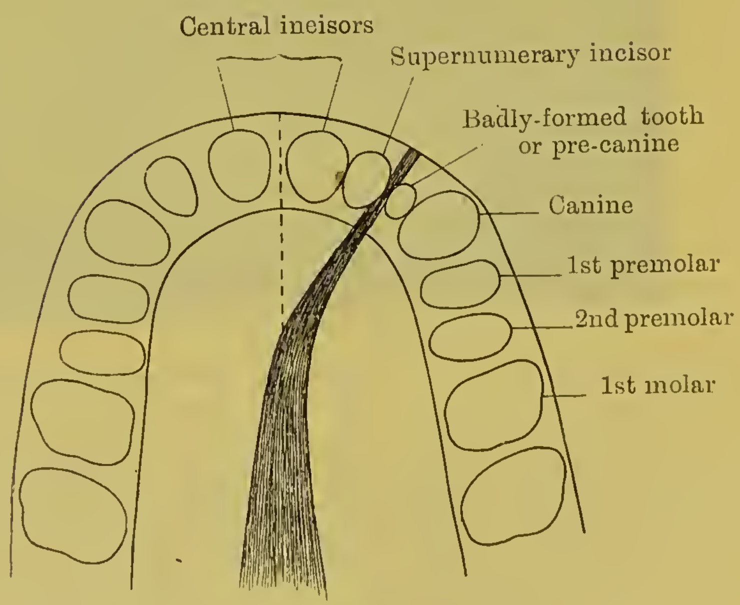

Fig. 18a.—Unusual arrangement.

FIG. 19.—A model showing a supernumerary incisor with the central incisor geminated with another tooth.

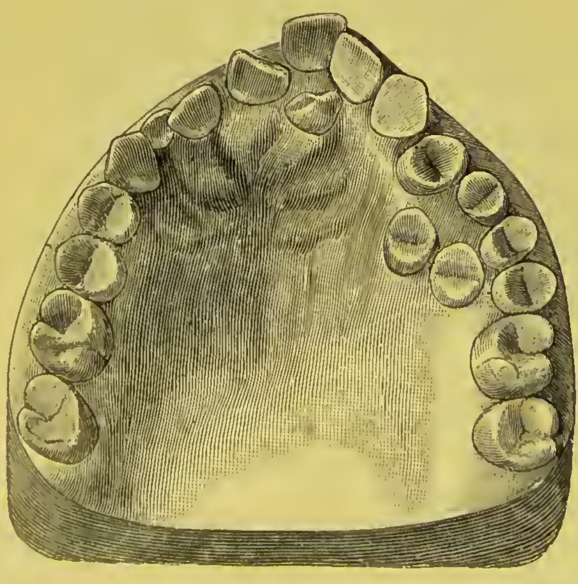

FIG. 20.

in the situation of the third molar, erupted either internally or externally to the arch.

Fig. 21. This case was reported in the *Dental Cosmos*, December, 1891. The patient was a man aged 41; the supernumerary teeth had erupted at the age of 35.

Supernumerary molars in the mandible are rare.

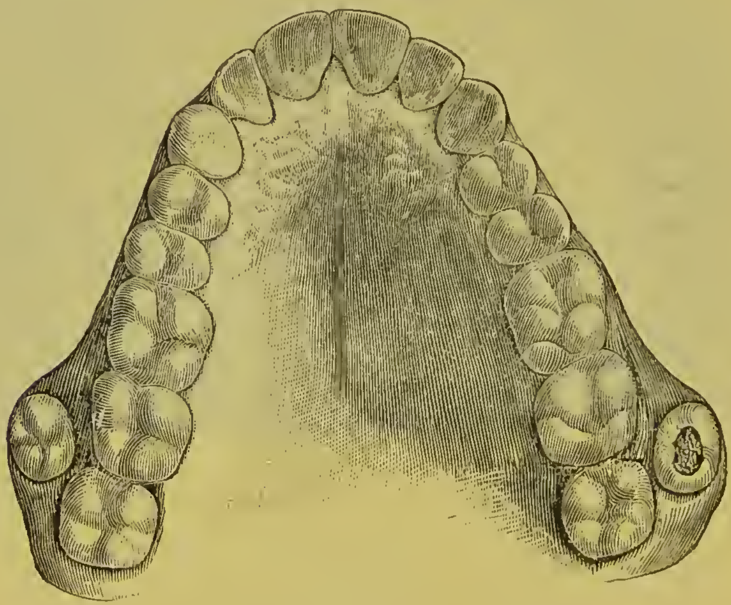

FIG. 21.

An unique case of supernumerary teeth is given in Tomes.[2] The following was the dental formula:—

$$\text{i. } \frac{5}{4}, \text{ c. } \frac{1}{2}, \text{ pm. } \frac{3}{0}, \text{ m. } \frac{3}{3}\,\frac{3}{4}.$$

The first two molars were furnished with accessory lobes. A brother of this patient had—

$$\text{i. } \frac{4}{4}, \text{ c. } \frac{1}{1}, \text{ pm. } \frac{2}{1}, \text{ m. } \frac{3}{3},$$

and a sister—

$$\text{i. } \frac{3}{3}, \text{ c. } \frac{1}{1}, \text{ pm. } \frac{2}{1}, \frac{2}{2}, \text{ m. } \frac{3}{3},$$

a grandmother had—i. $\frac{5}{4}$.

[2] "A System of Dental Surgery," 4th edition, p. 72. The case is recorded by Prof. Cope.

In the second class, abnormal in shape, many varieties of shapes are met with, but the two following are the most common types, namely, the conical and tuberculated (figs. 24, 25),. The number of these teeth varies, and cases are recorded where five, or even six, have erupted. The conical ones are met with in the median line

FIG. 22.—Conical supernumerary tooth between the two central incisors.

FIG. 23.—Tuberculated supernumerary tooth replacing central incisor.

between the central incisors, and may be either in front or behind them. They are also found in the molar regions, and, at times, appear as accessory cusps, being geminated with the molars. The tuberculated varieties usually appear on either side of the median line, immediately posterior to the upper central incisors, which may

be displaced. They are sometimes symmetrical. In addition to the above situation, supernumerary teeth may occur in any part of the mouth. They are found more often in the maxilla than in the mandible, and when occurring in the latter, are usually in the molar regions.

FIG. 24.—Supernumerary teeth.

(a) (b) (c) (d)

FIG. 25.—Two supernumerary teeth of the tuberculated variety from the same mouth. (*b*) and (*d*) show the appearance of the crown surface of (*a*) and (*c*) respectively.

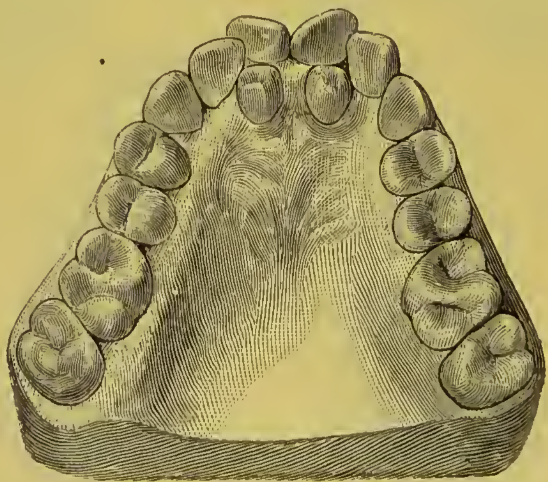

FIG. 26.—Two supernumerary teeth immediately posterior to the central incisors.

The case shown in fig. 27 is of interest, and is copied from the *Cosmos*. The supernumerary here was quite free from the molar.

It is extremely rare for abnormally-shaped supernumerary teeth to have more than one root. A conical supernumerary tooth with two roots is shown in fig. 30.

Relation of supernumerary teeth in the deciduous to those in the permanent dentition.—A few examples of supernumerary teeth in the deciduous dentition being followed by a similar condition in the permanent series have been recorded. In the *Transactions of the Manchester Odontological Society* (vol. iv., no. 6), Mr. George

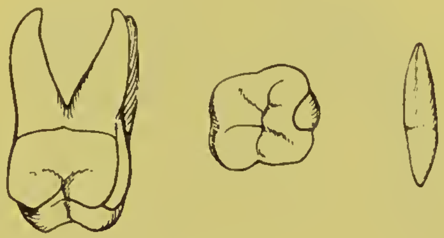

FIG. 27.

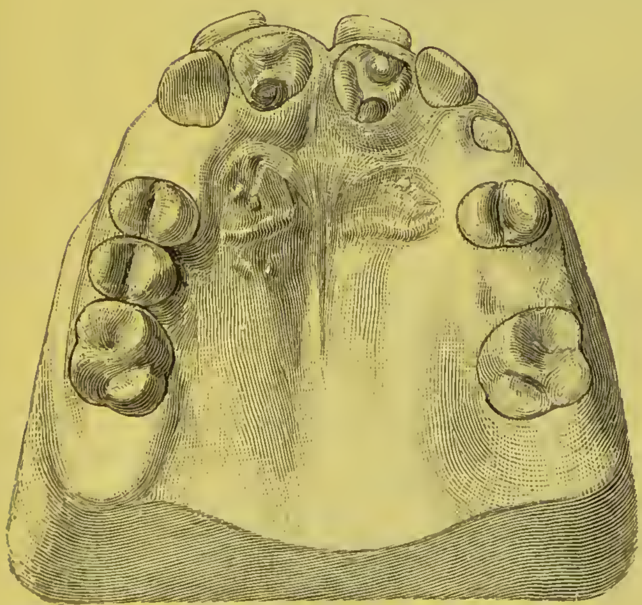

FIG. 28.—Two tuberculated supernumeraries immediately posterior to the central incisors. From the museum of the Students' Society of the Dental Hospital of London.

FIG. 29. — Supernumerary tooth from region of the first maxillary molar. The tooth erupted in an inverted position.

Whittaker reports one where two deciduous supernumerary mandibular incisors were followed by permanent supernumerary teeth. A similar case has been recorded by Mr. J. Ackery. Such cases are, perhaps, more common than is generally thought, and the comparative rarity of recorded cases is no doubt due in a great

measure to the fact that children are but seldom seen by the dental surgeon until after the loss of the deciduous incisors. Some statistics of the frequency of supernumerary deciduous teeth being followed by supernumerary permanent teeth, and geminated deciduous teeth by geminated permanent teeth, would be both interesting and instructive.

Origin of supernumerary teeth.—It is difficult to account for the origin of supernumerary teeth. The ordinary cone-shaped variety appears in two situations, namely, the median line towards the front of the mouth and in the region of the molars. In these regions masses of epithelium, called epithelial pearls, are frequently met with, and Mr. Bland Sutton suggests that the same tissues which develop them also give origin to the cone-shaped variety of supernumerary teeth.

Fig. 30.—A conical-shaped supernumerary tooth with two roots. From the Museum of the Victoria Dental Hospital.

The tubercular types of teeth are invariably met with in the incisor region, and there would appear to be some relation between them and the supernumerary incisors. The frequent presence of extra teeth in the incisor region is attributed, by some, to "atavism."

Treatment.—Supernumerary teeth, abnormal in shape, frequently appear before the permanent teeth situated in the same region. They should be removed as soon as they are recognised. In cases, however, where their presence has been overlooked and a crowded condition of the teeth has resulted, it may be advisable, under certain conditions, to retain them.

(*b*) **Deficiency in number.**—Deficiency in number may vary from a single tooth to the whole series.

The commonest condition is that in which only one or two teeth are absent. The maxillary laterals are, perhaps, most frequently missing, after them the second mandibular premolars and the

maxillary third molars. With regard to the absence of the last-named teeth, in all suspected cases care must be taken to see that the teeth supposed to be first and second molars are not in reality second and third molars, the first having been lost at an early age.

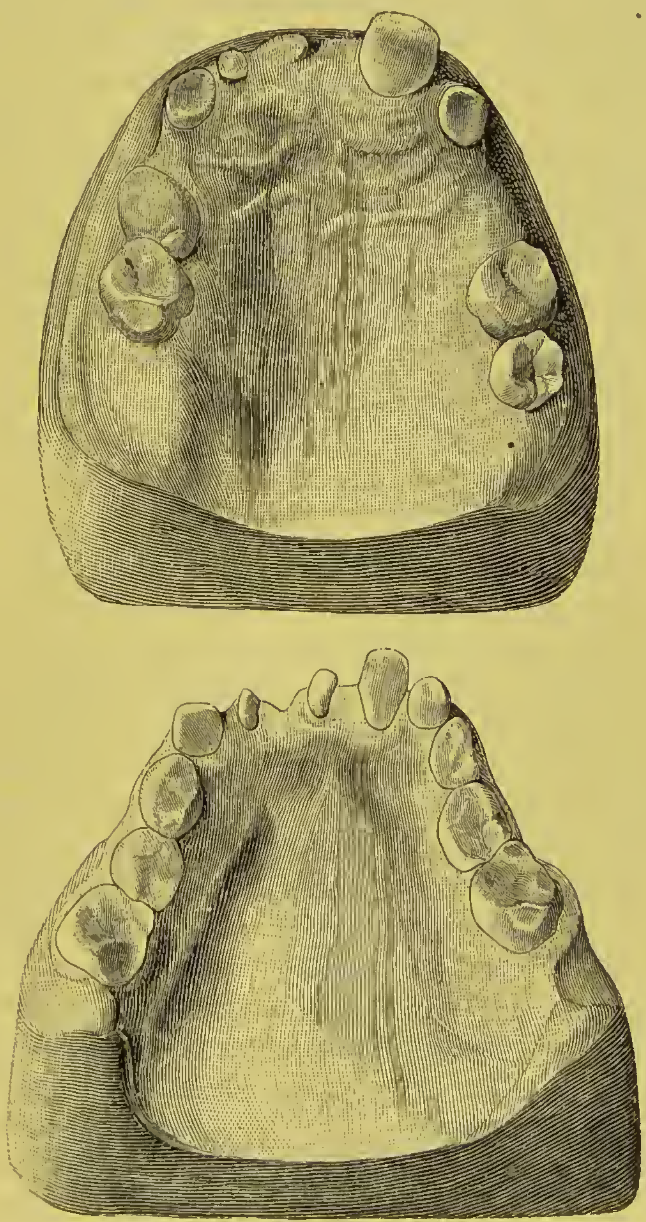

FIG. 31.—Models showing deficiency in number of permanent teeth. The patient was a man, aged 35.

A large number of patients (especially female) are met with in whom the deciduous canines persist. In these cases the permanent successor is frequently present, but situated in an erratic position.

The congenital absence of a tooth or teeth can only be determined by means of the X-rays. The whole group of incisors, maxillary and mandibular, may be absent, occasionally the premolars, and very rarely the molars. Only one example of absence of molars has come under my notice. Several cases have been reported where a large number of the permanent teeth are absent; in these patients the first molars are usually present on either side in maxilla and mandible, and one or two badly-shaped teeth in the incisor region (fig. 31). In a case reported by Mr. Ackery[1] in a woman aged 24, only six permanent teeth were present, namely, in the maxilla the central incisors and first molars; in the mandible the first premolars. In a case which occurred in the practice of Mr. T. Clarence, two boys, twins, both presented marked deficiency of permanent teeth.

One of the most interesting cases is recorded by Dr. Jarre.[2] In this patient there were no deciduous teeth until fifteen months, when a tooth appeared in the maxilla on the left side of the median line. This tooth was conical in form. Four months later a similar tooth appeared on the right side. At the age of twenty-three months a tooth erupted in the situation of the right maxillary lateral. About the third year two more teeth appeared in the maxilla on the right and left sides, the size and form of deciduous molars. No teeth appeared in the mandible. At the age of seven years the three teeth in the incisor region were replaced by three more, still conical in form. The deciduous molars were persistent at the age of twelve, when the condition of the jaws was as follows: in the maxilla five teeth, three being permanent, two deciduous; in the mandible no teeth. In this patient the hair on the head was scanty, the scalp being readily seen under it, while on the rest of the body no hairs were present. The nails presented peculiarities. They were covered with white opaque spots and streaks, which occupied the whole thickness of the tissue, this condition having been present since birth. The lens was normal. The skin was loose and wrinkled. The fact that in this case the teeth, nails and hair have been influenced in their nutrition is interesting.

A remarkable case of entire absence of teeth accompanied by marked deficiency of hair is recorded by Guildford.[3] The patient,

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[1] *Trans. Odont. Society*, 1891, vol. xxiv., p. 40.

[2] *Dental Cosmos*, June, 1892, p. 468.

[3] *Transactions World's Columbian Dental Congress*, p. 257.

a man aged 48, was nearly bald, there being only a slight covering of down. Hair was present in the pubic and axillary regions, but the surface of the body entirely lacked the surface hairs usually present. There was an absence or suppression of the sudoriferous glands, for he had never perspired. In addition, he had no sense of smell or taste. Of his six children two showed signs of inherited abnormality in having only about half the usual number of teeth.

Cases of **deficiency of teeth associated with abundance of hair** have been recorded. Fedor Jeftichigen, the dog-faced man, whose entire body was covered with hair, and on whose face, including the nose and forehead, there was a plentiful growth several inches in length, had only six teeth, two in the maxilla and three in mandible—one had been extracted. In this person the sudoriferous glands were but poorly developed. In the case of the Burmese hairy family, consisting of grandfather, mother and son, there is no reliable record of the teeth. From the above cases it is evident that there is a correlation between the hair and the teeth. In one class there is a deficiency of both structures; in the other there is a deficiency of teeth associated with a redundance of hair.

Mr. Maggs[1] has recorded a case where **defective development of the permanent teeth** was **associated with malformation of the eyes and anus.** The patient was a girl aged 18. The anus, imperforate at birth, was established by operation. In the maxilla the incisors and molars were absent. In the mandible ten teeth were present; the teeth were badly formed. The condition of the eyes was as follows: each eye was very deficient in size (microphthalmos); there was almost complete absence of irides, but the lenses were present, as ascertained by oblique illumination. Each eye had thirteen dioptrics of myopia, as ascertained by keratoscopy. This myopia was not improved by spherical glasses. The ophthalmoscope showed the discs to be small. There was no coloboma of choroid, but a few patches of opaque nerve fibres were seen in the retina. Vision was defective in each eye. There was nothing suggestive of specific disease. The teeth and nails were normal.

(2) **Deciduous dentition.**—Absence of one or more deciduous incisors, either maxillary or mandibular, is **not so common as an excess** in number. These supernumerary teeth simulate in shape

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[1] *Trans. Odonto. Society*, vol. xxii., p. 181.

those in the neighbourhood of which they are found. They are generally found in the incisor region. In a case which Mr. Ackery reported, and the history of which he followed, the deciduous teeth in the incisor region were succeeded by six permanent teeth. A model showing two supernumerary deciduous incisors is shown in fig. 32, and one showing absence of a lateral incisor in fig. 33.

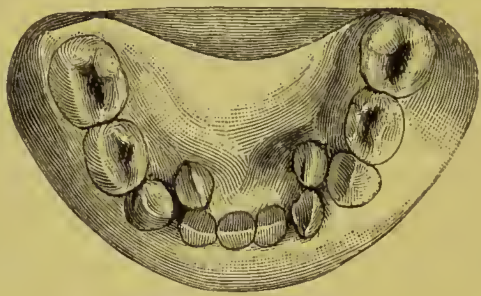


Fig. 32.

Fig. 33.

(C) VARIATIONS IN STRUCTURE.

Under this heading are included certain variations in form, shape, or structure which have resulted from acquired, congenital or hereditary causes. They will be considered under the following heads :—

(1) Variations produced by constitutional disturbances.
(2) Variations produced by local disturbances.
(3) Gemination.
(4) Enamel nodules.
(5) Variations in the number of cusps and roots.

(1) VARIATIONS PRODUCED BY CONSTITUTIONAL DISTURBANCES.

(*a*) Syphilitic teeth.—It is an established fact that congenital syphilis may leave, as one of its marks, a characteristic deformity of certain of the teeth. The effect that syphilis produces upon the eruption, both of the deciduous and permanent teeth, was referred to on a previous page. Here it is proposed to deal with the anatomical condition of the deformity. The teeth generally affected are the permanent incisors, both upper and lower, at times the canines,

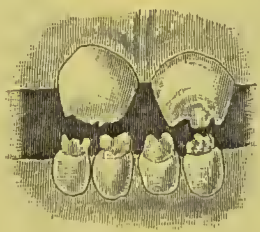


FIG. 34.—Two maxillary and four mandibular incisors (permanent) of a girl, the subject of inherited syphilis, showing the appearance when the teeth have been recently cut. *Trans. Odontological Society*, vol. ii. (Old Series).

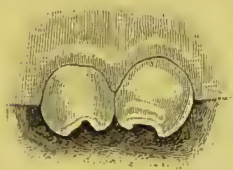


FIG. 35.—Central incisors from a lad aged 15, the subject of inherited syphilis. *Trans. Odontological Society*, vol. ii. (Old Series).

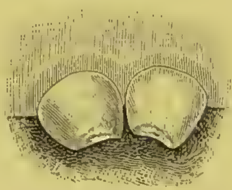


FIG. 36.—Central incisors from a patient, the subject of inherited syphilis, the notches being less deep, but the narrowing more marked than in fig. 35. *Trans. Odontological Society*, vol. ii. (Old Series).

and frequently the first molars. The incisors are small, peg-top-shaped teeth, standing apart so as to leave increased interspaces. These teeth are generally of a dusky earthy hue, which has been likened to "size," though such discolouration does not always occur.

The distal margins of the centrals are generally turned outwards, and it will also be noticed that the alveolar portion of the jaw in the incisor region is imperfectly developed. The teeth are generally affected symmetrically, but exceptions occur, as, for

example, when one incisor is perfectly formed and the other presents the typical syphilitic form.

In a healthy tooth when just erupted the cutting edge is seen to be surmounted by three little tubercles separated by two shallow notches, and the tubercles being rapidly worn down by attrition the cutting edge soon appears quite straight. In the syphilitic tooth these tubercles and notches are well marked, and the central tubercle is badly developed ; the effect of attrition is to produce one

(a) (b)

FIG. 37.[1]—The syphilitic molar (a) is shown in contrast with a normal-shaped molar (b)—both slightly enlarged. The patient from whom the syphilitic molar was removed was under the care of Mr. E. P. Collett. There was a typical history of congenital syphilis.

central notch between the two outside tubercles. It is this central notch that is said to give to syphilitic teeth one of their characteristic appearances, but, as will be subsequently shown, it must not be solely relied upon in diagnosis, as it appears to be produced in teeth where there is not the slightest taint of congenital syphilis. Syphilitic teeth are said to be "soft" in structure, and as a consequence are attacked by caries or quickly worn away by mastication. Many patients, however, are seen with characteristic syphilitic teeth in which the enamel appears to be quite normal. The laterals are not always deformed, the centrals being considered by Mr. Jonathan Hutchinson as the "test" teeth. Dr. Leon Williams has found in the case of a syphilitic tooth which he examined microscopically, that the enamel was of very faulty character and that the dentine contained interglobular spaces in abundance.

[1] From a photograph by Mr. G. G. Campion.

The deformity of the canines shows itself by a circumferential notch occurring near the cutting edge or point of the crown.

The molars, like the centrals, are smaller than normal. They are dome-shaped, and the crown surface is of an irregular pattern, instead of having well-developed cusps (see fig. 37).

The *diagnosis of syphilitic teeth* is easy, though at times abnormal teeth are met with which somewhat simulate them. For instance, in patients who have suffered from rickets a distinct tapering notched tooth is sometimes seen, and in some cases of the so-called "honeycombed" teeth, where the deformity is confined to the edge, the central portion wears down more rapidly than the side. The

FIG. 38.[1]—Model showing syphilitic incisors.

notch produced upon the teeth by the use of a clay pipe should not be mistaken for a syphilitic notch, as it would be unilateral and altogether different in character. The diagnosis of congenital syphilis can also be confirmed by the presence of other lesions, such as scars radiating from the angles of the mouth, dusky-coloured skin, prominent forehead, broad depressed bridge of nose, and interstitial keratitis.

Children who suffer from phagedænic ulceration of the mouth, syphilitic in origin, are generally free from the typical teeth. It is as well to remember that the diagnosis of congenital syphilis by no means rests upon the presence or absence of these teeth, for they are only met with in a small proportion of cases. Mr. Moon has afforded an explanation of the deformity. He believes that "the peculiar shape results from a stunted development of the first

[1] From a photograph by Mr. G. G. Campion.

formed portion of dentine, in other words, a dwarfing of the cusps; and that the single central notch on their cutting edge is due to a greater diminution in the size of the central than the lateral lobes."

That the incisors and molars should be affected is said to arise from the fact that at the time these teeth are in the course of formation, the effects of congenital syphilis would be most active. Syphilis is said only to affect the permanent dentition, but Mr. Oakley Coles has recorded a case of peg-shaped deciduous teeth, which were very characteristic, occurring in a child whose mother had long been the subject of syphilis.

(*b*) **Rachitic Teeth.**—Rickety patients frequently have sparse teeth slightly tapering, and this is seen not only in the incisor region but also in the premolar and molar regions. The tapering is at

FIG. 39.—Maxillary central and molars, showing hypoplasia.

times well marked, and, in addition, there is a slight notch in the centre somewhat simulating the notch of syphilitic teeth, and unless care is taken the one may be mistaken for the other. Rickety teeth have often a bluish translucent appearance, the enamel being very smooth. The tapering form may be due to the same cause as the syphilitic, viz., arrest in development or calcification of the central denticle.

(*c*) **Hypoplastic Teeth** (honeycombed teeth).—The condition produced varies from a well marked pitting (fig. 39) to a slight grooving of the enamel (fig. 40).

Macroscopical appearances.—The enamel is found to be wanting in its normal glossy appearance, and instead of being smooth and even, is indented by small pits or grooves, the number of which varies. These pits may be arranged either in rows running transversely across the tooth, or in rare instances they may run in a vertical direction in two rows, situated in the places where the

central denticle is supposed to unite with the two lateral; when the pits coalesce, an irregular groove is formed. Between the different rows of pits perfect enamel may be found, or the rows may be so numerous that the whole surface presents an extremely irregular appearance. The extent of tooth surface attacked will vary; in some cases only a portion will be involved, in others the complete crown. The teeth generally affected are the centrals, laterals,

(*a*) (*b*)
FIG. 40.

canines, and first permanent molars. When the condition attacks only the part towards the cutting edge, the laterals are frequently found free, a proof that their calcification frequently starts subsequent to that of the canine. In other cases these teeth are found quite free, while the premolars, with the second permanent molars, are pitted, and in rarer cases still the whole of the crowns of the teeth will be implicated. In this last condition the incisors are generally thin and sharp, the premolars and molars presenting also sharp cusps. Instead of rows of pits the abnormality may show

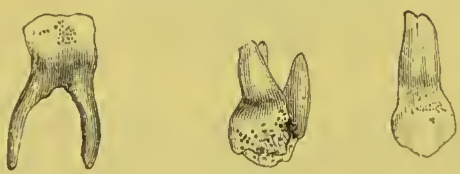


FIG. 41.

itself in slight grooves on the surface of the enamel, which otherwise appears normal (fig. 40).

Occasionally, only the extreme tip of the incisors is attacked, and as the central portion apparently develops before the sides, it will be more affected, and so in process of mastication become worn down or broken off, thus giving rise to a well-marked notch; this notch, like the one seen in rickets, must be carefully discriminated from the notch which is the result of syphilis.

Hypoplastic teeth are met with in the deciduous dentition. In the three specimens figured this condition is well shown (fig. 41). In the canine the enamel has been attacked in the neighbourhood of the neck, proving that the lesion was produced by some cause acting after birth, while in one molar the enamel attacked is on the masticating surface, and the lesion was therefore probably due to some arrest of development *in utero*.

FIG. 42.—Section of fig. 40 (*b*).

Microscopical appearances.—The enamel will be found to be extremely thin in the position of the pits or grooves, and may, in some cases, be entirely absent. The striation of the enamel prisms is generally well marked, and the condition known as the "brown striæ of Retzius" also present. In severe cases, the enamel in parts appears as a homogeneous brown mass. The dentine is seen to contain a large number of interglobular spaces, and in those teeth where the cause has acted intermittently, these spaces will be found arranged in rows, taking an upward and inward direction, and corresponding to the pits or rows upon the enamel (see fig. 42).

Dr. Grevers, of Amsterdam, has pointed out that in some cases

the defect visible on the surface is continued through the whole thickness of enamel.

Frequency of Hypoplastic Teeth.—These defective teeth are most frequently met with in the lower classes. Mr. Sidney Spokes[1] finds that in 258 boys in one of the Public Schools 4·6 per cent. had hypoplastic teeth, whilst in 1463 boys and girls belonging to a Poor-Law school the number affected was over 7 per cent., and in 183 from a Poor-Law Ophthalmic School the figures reached about 15 per cent. In these figures enamel defects of the incisors and molars were alone included. Mr. Sidney Spokes found in 250 infants 15 cases of hypoplasia.

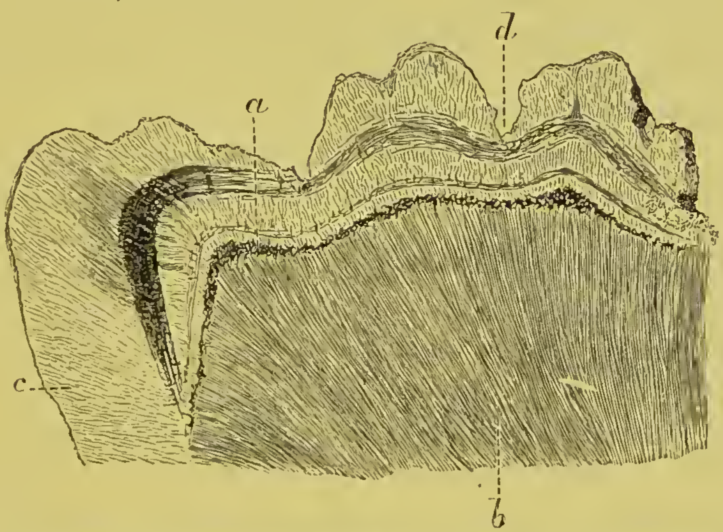


FIG. 43.—Section through a hypoplastic molar. (*a*) Interglobular spaces, (*b*) dentine, (*c*) enamel, (*d*) a pit upon the masticating surface.

Etiology.—In seeking the cause of the deformity it must be remembered that the period at which the deformed enamel was being calcified must synchronise with the activity of the supposed cause. In most cases the malformation is on the crowns of the central incisors, the laterals and the canines towards the cutting edges and on the crown surfaces of the first molars. This points to a cause acting during the first two years of life. Mr. Jonathan Hutchinson attributes the deformity to a stomatitis arising from the use of mercury. It will frequently be found on enquiry that patients with hypoplastic teeth were given mercury for convulsions, &c., during

[1] *Journ. of the British Dental Assoc.*, 1897, p. 31.

teething, or some form of teething powders containing mercury was used. On the other hand it should be remembered that many patients come under notice to whom no teething powders have been administered, but the hypoplastic teeth are nevertheless present; and still further cases are seen where teething powders, including Stedman's, were freely administered during the process of teething without apparent effect upon the structure of the teeth.

An interesting case came under notice at the Dental Hospital of London. A boy aged 3½ years was sent to me, suffering from well-marked stomatitis due to the administration of mercury. At this period calcification is taking place in the premolars. These teeth have since erupted with the enamel in all respects perfectly formed. In this case the stomatitis did not lead to hypoplastic teeth—indeed, there is but little evidence to connect mercury with hypoplastic teeth in the relation of cause and effect.

It has been asserted that the epileptiform convulsions associated with such cases during infancy are the cause of the deformity, while others state that it is the mercury given to cure the convulsions which produces the abnormality. These are not satisfactory explanations; and the following case is of interest as bearing upon the above. A patient, D. P., had three attacks of convulsions during teething, for which no mercury was administered. The enamel of the teeth in this patient was slightly deformed. The remaining members of the family had no convulsions, but nevertheless were given a numberless supply of teething powders, and yet the teeth were quite normal; this case goes to show that the convulsions and defective development were associated. It seems more rational to regard both as effects from a common cause, rather than one as the cause and the other as the effect. From the history of many cases it would appear that this defective dental development is due to mismanagement in the feeding of infants, as a large number of children with these teeth have been fed upon artificial foods.

Dr. Kingston Barton, who has given much attention to this question and has kept careful records, states that in 202 children he found 10 cases of hypoplasia in the permanent and 5 cases in the deciduous series. These latter occurred out of 67 hand-fed children. Out of the 202 cases 54 were fully breast fed, and in these no hypoplasia was present. He also adds that in two cases of very bad artificial feeding very early and extensive caries occurred.

Lamellar cataract is often associated with hypoplastic teeth, and Mr. Hutchinson has ascribed the hypoplastic teeth to the mercury given for the lamellar cataract; but as with the convulsions, it seems more rational to believe both to be the result of a common cause. Certain cases of hypoplastic teeth can be traced distinctly to the effect of one of the exanthemata, though it must be remembered that not every case of an exanthemata occurring during infancy will affect the teeth. The facts which point to the exanthemata being the active cause in some cases are, briefly, that in children who have had one of the eruptive fevers during infancy, but who are otherwise healthy, no distinct structural defects can be detected; and that the period during which the portion of tooth which is defective was calcifying is synchronous with the attack of the fever; and, again, there is the *primâ facie* probability that the eruptive fevers, which expend their force principally upon the skin and epithelial structures, should affect all epithelial structures, including the teeth.

Of the fevers, measles seems to be most prone to produce the deformity, next after that, scarlet fever. At first sight it would seem possible that each separate fever would produce characteristic results, but such does not seem to be the case, it being apparently impossible to tell which fever has been the cause. In support of this we may quote the following case, which occurred under the care of Mr. Bull: A. D. had an attack of scarlet fever, followed at a short interval by an attack of measles, when two years old. The attacks were only slight, and little or no effect could be detected on the buccal surfaces of the incisors, but on the lingual surfaces of both the centrals and laterals appeared two slight rings, rather more than half way up. Both rings were precisely similar in appearance, and no doubt were the result of the two different attacks of fever.

(*d*) Gout is said to produce characteristic teeth, but on careful examination it will be found that the "characteristics" are merely the result of early recession of the gums, combined with marked attrition upon the masticating surfaces, making the teeth appear bony with squarish tops, and are therefore not true characteristics.

(2) Local causes.—Defects in the structure of teeth may in rare instances be produced by local causes. Defects in a single tooth of a series may take the form of a pit, ring, or patch, or may extend to the total absence of enamel. The premolars are usually affected,

and Mr. Spokes finds that the condition is more frequently seen in the mandibular premolars and in the second more than in the first. In one case of local defect which came under notice the distal half of the maxillary left canine was covered with small pits, the mesial half being quite normal (see diagram, fig. 44).

Fig. 44.

In one case met with, a patient had a single premolar affected, and there was distinct evidence of suppuration in connection with the deciduous predecessor. In another instance, a patient had a distinct line of pits halfway down the right lower central, and her mother remembered the child receiving a severe blow on the chin, injuring the deciduous predecessors and leading to their early loss. Mr. Spokes, however, was unable in the thirty-seven cases he met with to establish a history of suppuration in connection with the deciduous predecessors, and curiously enough was able to note seven cases of suppuration where the premolars were perfectly formed.

(3) **Gemination.**—By gemination is understood the union of two or more teeth by means of one or more dental tissues.

(*a*) Permanent dentition.

Molars are sometimes geminated and also lateral incisors and canines, but gemination is very rare between canine and premolar, premolar and premolar, first molar and premolar.

Supernumerary teeth are at times geminated with permanent ones. This is more frequently seen in the molar region (fig. 51), but it is not uncommon to find a central or a lateral incisor united with a supernumerary lateral, and care should be taken

before expressing an opinion as to the absence of a permanent tooth, to see that it is not united with its neighbour; further, an abnormally large tooth should be differentiated from two geminated teeth.

FIG. 45.

FIG. 46.

From specimens in the Museum of the Odontological Society.

The union between geminated teeth may take place throughout the entire length of the teeth, or it may be restricted to the crowns (figs. 45 and 46).

The following figures show several forms of gemination. In fig. 47, two mandibular incisors united throughout their whole length

FIG. 47.

FIG. 48.—From a specimen in the possession of Mr. J. Smith Turner.

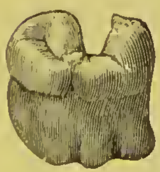


FIG. 49.

FIG. 50.

are seen, while in fig. 48 a similar condition in the maxillary teeth is shown; fig. 46 is a specimen in which the crowns only are united; in figs. 49 and 50 two molars are geminated; in fig. 51 a molar and supernumerary tooth are united; fig. 53 is a model

showing symmetrical gemination of centrals with supernumerary laterals.

The union, when the crowns alone are involved, is by continuity of both dentine and enamel; in these cases there may be either a common or two pulp chambers. When the whole length of the tooth is involved, a similar condition exists, with the addition that there is also a continuity of cementum.

FIG. 51.

FIG. 52.—A supernumerary tooth attached to the roots of an upper molar, the supernumerary tooth being inverted.

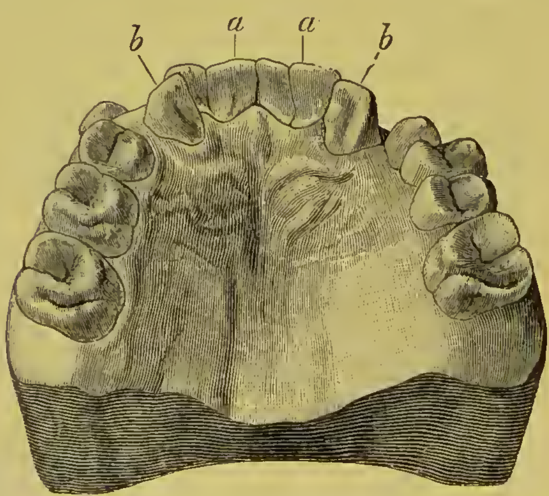


FIG. 53.—(*a*) Geminated central and supernumerary lateral incisors; (*b*) lateral incisors.

FIG. 54. FIG. 55.

From the *Journal of the British Dental Association.*

A curious case of gemination has been recorded by Mr. E. Goodman.[1] The mass occupied the position of the right superior central incisor, and was found to be composed of three distinct teeth, the appearance presented being shown in figs. 54 and 55; the lateral incisor was present.

FIG. 56.—From a specimen lent by Mr. Somerling. This tooth was removed from the region of the mandibular second molar.

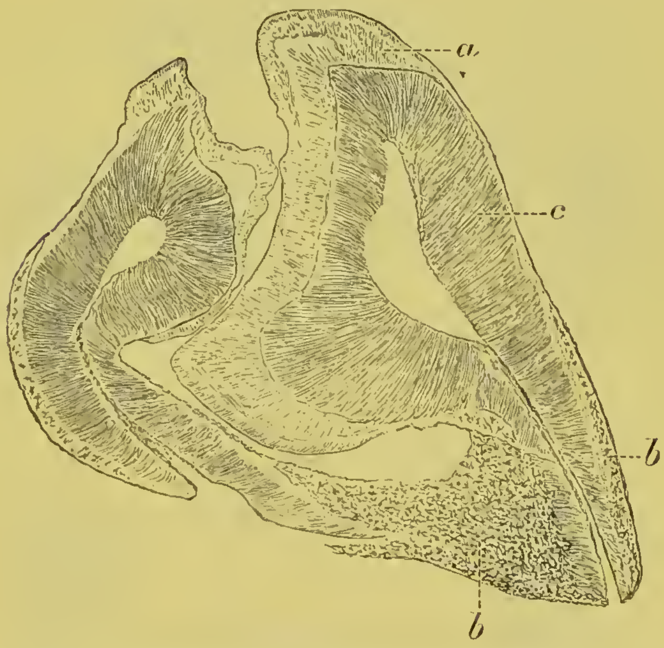


FIG. 57.—Section of fig. 56 —(*a*) enamel; (*b*) cementum; (*c*) dentine.

There is reason to suppose that some of the abnormally shaped teeth, formerly termed *odontomes coronaire*, are in reality examples of gemination. The specimen shown in fig. 56 proved on section to be two geminated teeth (see fig. 57). The tooth shown in fig. 58 was removed from the maxilla in the molar region. The greater part of the crown was destroyed by caries. The lower

[1] *Journal of the British Dental Association*, vol. xv., p. 28.

portion consisted of a globular mass of tissue covered by a layer of cementum. A section of this tooth, as seen in fig. 59, indicates the fusion of two teeth with separate pulp chambers. The gemination in this case is not so well marked.

FIG. 58.

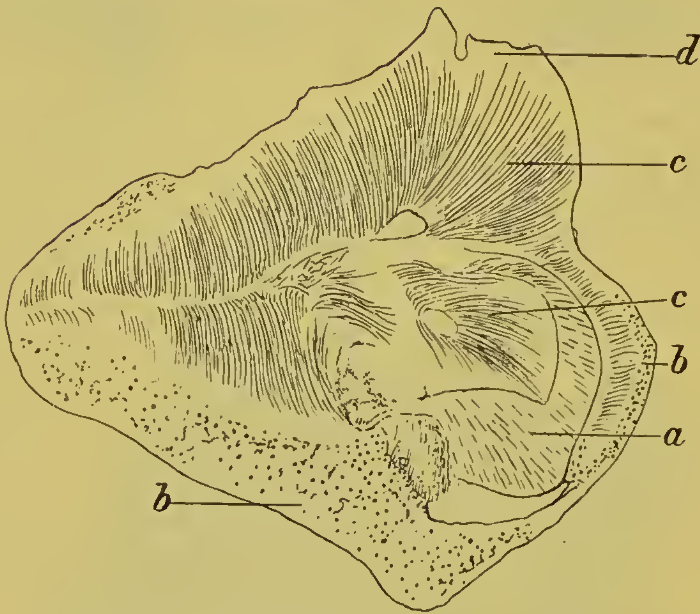


FIG. 59.—(*a*) Enamel; (*b*) cementum; (*c*) dentine; (*d*) carious dentine forming portion of crown.

(*b*) Deciduous Dentition.

Geminated teeth are more often met with in the deciduous than in the permanent dentition; they are rarely symmetrical, and occur in the mandible more frequently than in the maxilla. The lateral incisor and the canine are the teeth generally united, but gemination of the central and lateral incisors has also been recorded. Mr. W. Hern has recorded a case where geminated teeth were followed by the absence of a permanent incisor in the same region, which points to the fact that only one germ was given off from the two teeth.

In some cases the line of fusion is well marked (fig. 60, *a* and *b*), in others scarcely perceptible (fig. 60, *c*). The union is by continuity of dentine with dentine; in some examples the pulps coalesce. An example of gemination of three deciduous teeth is shown in fig. 61.

(4) **Enamel nodules.**—Enamel nodules are those small excrescences, apparently consisting of enamel, occasionally met with upon the roots of teeth. They are generally found upon multiple-rooted

(*a*) (*b*) (*c*)

FIG. 60.

FIG. 61.—From a specimen in the Museum of the Odontological Society.

FIG. 62.

FIG. 63.

FIG. 64.

Enamel nodules. From specimens in the possession of Mr. J. Smith Turner.

FIG. 65.—Maxillary molar with two enamel nodules. From a specimen belonging to Mr. L. Read.

FIG. 66.—Maxillary molar showing large enamel nodule.

teeth, being situated a little below the neck, and often at the junction of two roots. On section they are found to consist of a cone of dentine covered with a rather thick layer of enamel (fig. 67). It will often be found that a sharp lamina of enamel connects the nodule with the crown of the tooth. Although generally seen upon

multiple-rooted teeth, they are occasionally met with on teeth with single roots, Mr. Tomes, in his "Dental Surgery," figuring one on p. 121, and Mr. Campion has in his possession a lower premolar with a large nodule just below the neck. The specimen (fig. 66) represents a very large nodule between two palatine roots of an upper molar, and is in the possession of Mr. L. Read, while that in fig. 68, from the Museum of the Odontological Society, shows a nodule situated at the apex of the root of an upper molar.

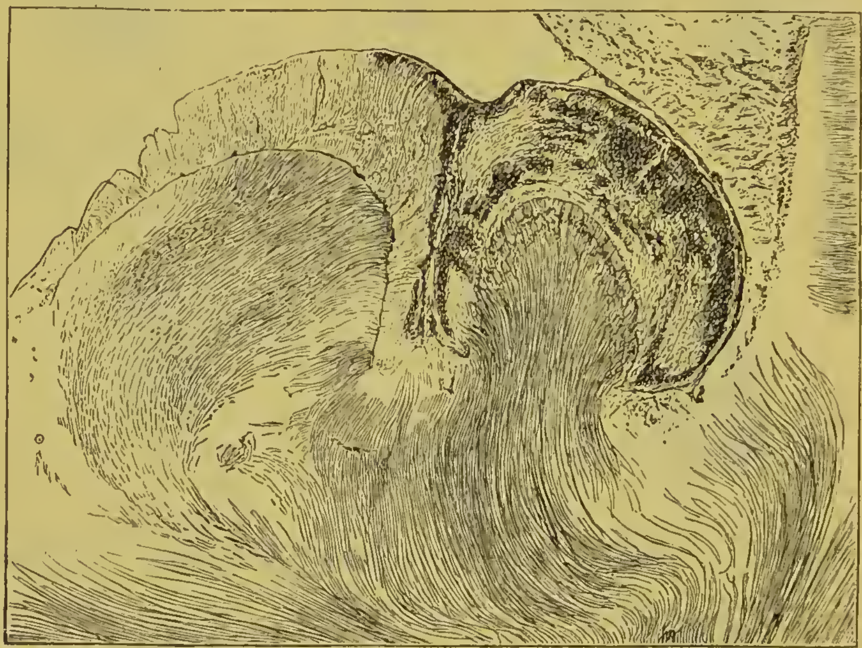


Fig. 67.—Section through an enamel nodule upon a maxillary second molar.

The transition from enamel nodules to supernumerary cusps or teeth is probably one of degree only, and the same may be said of those prolongations of enamel which are seen running between the roots of multiple teeth, especially upper molars (figs. 69 and 70). Enamel nodules may be accounted for by dichotomy of the developmental germ, that is to say, a budding from the tissues connected with the process of tooth formation; but Wedl, in accounting for them, says, "It is obvious that the nodules or ridges which are met with upon the molars are the result of localised continuations of the development of the enamel between the already developed basal portion of the roots, and are produced by the strip of the

enamel organ which has persisted longer than the rest." Enamel nodules at times give rise to severe neuralgia.

(5) **Variations in the number of roots and cusps, and in the direction of the roots.**—In dealing with this division it is only possible to consider a few of the more common varieties. The variations from the normal caused by flexions and torsions of the roots are almost endless; in most instances these variations are due to movements of the developing tooth in mal-directions from crowding. The flexion of the root may take place at any part of the root from the neck to the apex, and may be single or multiple. The twisting varies considerably in amount.

Fig. 68.

Fig. 69.—Prolongation of enamel between the roots of a mandibular molar.

Fig. 70.—Prolongation of enamel between the roots of a maxillary molar.

(*a*) Permanent Dentition. (i.) Maxillary Teeth.

(*α*) **Central incisor.**—These teeth may be considerably flattened from before backwards (fig. 71), or the crown may be so altered in shape (fig. 72) as to resemble a simple cone. The cingulum may be well marked, and is frequently grooved mesially or even bi-lobed. The root often presents a postero-labial groove. An extra root is occasionally seen (fig. 73).

(*β*) **Lateral incisor.**—This tooth is very variable in the shape of its crown, the mesial and distal angles being so rounded as to cause the tooth to mimic a canine. The crown may be so diminished and altered as to appear like a conical supernumerary tooth. The

cingulum may be well developed and grooved mesially or even bi-lobed. A notch is at times noticeable on the cutting edge dividing it into two unequally-sized cusps. The root may be considerably flattened and grooved laterally, while flexions and twistings are often met with. An extra root is occasionally seen.

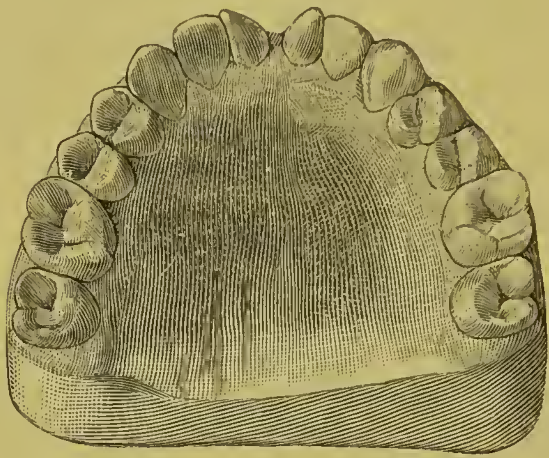


FIG. 72.—Model showing alteration in shape of upper centrals. Students' Society of the Dental Hospital of London.

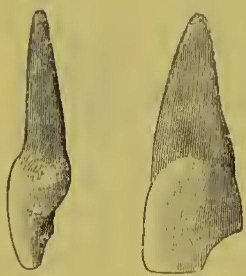


FIG. 71.

FIG. 73.

(γ) **Canine.**—This tooth may reach $1\frac{3}{8}$ inches in length. The root may be grooved and bifurcation of the apex may take place, but the latter is very rare. The root is often twisted in those teeth which erupt external to the arch. The development of the cingulum may be so marked as to cause the tooth to mimic a premolar. The cutting edge is at times divided into two unequal cusps by a notch.

(δ) **Premolars.**—The first premolar is very irregular as to its roots. Externally the root nearly always shows signs of bifurca-

tion, and in some cases two or three well-defined roots may be met with. When three roots are present they are arranged on the same plan as in the maxillary molar.

Fig. 74.—Upper lateral incisor, showing flexion of root near apex.

Fig. 75.

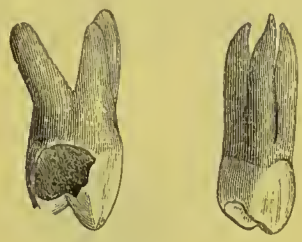


Fig. 76.—Three-rooted upper first premolars.

Fig. 77.—Two-rooted upper first premolars.

The second premolar is more constant in form than the first premolar. Two or three roots may be present. An extra cusp occasionally appears on the premolars (fig. 75).

Fig. 78.—Upper first molar, the posterior buccal and palatine roots being united by cementum.

Fig. 79.—Upper first molar, showing all three roots united by cementum.

(ε) **Molars.**—**The first molar** may have a fourth root, this is always situated between the anterior buccal and the palatine roots; a fifth root canal is more rarely seen between the fused posterior buccal and palatine roots. The roots may be fused together, a union of the posterior buccal and palatine being most common

(fig. 78). At times all three roots may be fused together (fig. 79). The buccal roots are often curved, and may approximate at their apices so as to embrace the septum.

An extra cusp is often seen on the mesio-lingual and, occasionally, on the buccal aspects. There is some evidence to point to

FIG. 80.—Upper first molars, with supernumerary roots between the anterior buccal and palatine roots.

the extra cusps in the latter situation being really due to gemination with a supernumerary tooth.

The second molar may present abnormalities similar to the first. A peculiar flattening of this tooth, as shown in fig. 81, is met with.

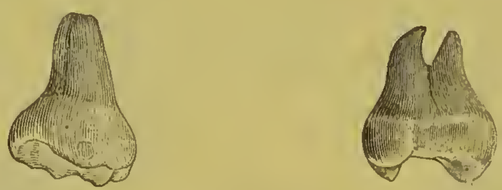


FIG. 81.—Abnormally shaped upper second molars.

The third molar presents an immense variety of shapes. The roots may be all fused together, and in one specimen in the Museum of the Odontological Society the apex is cup-shaped with numerous holes for the vessels of the pulp to enter. The roots may be increased in number and flexions are often present (figs. 82 and 83).

The normal position of the roots of the molars may be altered by the posterior buccal being displaced inwards and forwards. This variation is termed "oblique rooted," and attention was first drawn to it by Mr. Booth Pearsall (*Jour. Brit. Dent. Assoc.*, 1891) (see figs. 84 to 87).

(ii.) Mandibular Teeth.

(*α*) **Incisors.**—An extra root may arise from the approximal or lingual surface.

(*β*) **Canine.**—This tooth may have two roots. The root may be bifurcated or an extra one may be present. In the former the variation usually occurs in both canines.

FIG. 82.—Abnormal upper third molar.

FIG. 83.—Upper third molar, showing a peculiar flexion of the buccal roots.

FIG. 84.—Normal left upper first molar.

FIG. 85.—Oblique-rooted left upper first molar.

FIG. 86.—Normal right upper second molar.

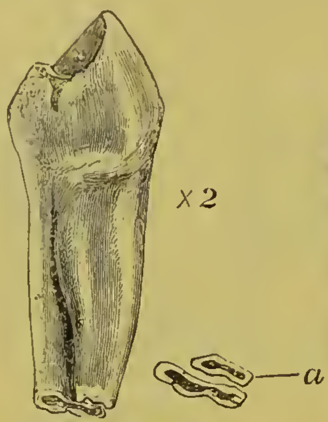
FIG. 87.—Oblique-rooted right upper second molar.

FIG. 88.—Two-rooted lower canine.

(*γ*) **Premolars.**—The first premolar may have two roots. "When a lower premolar tends to have two roots they are peculiarly formed, the flattened apex being bent round so as to form an approach to a second (anterior) root, and this may go on to complete division" (Tomes) (figs. 89 and 90). The inner cusp of this tooth

is at times but feebly developed and causes the tooth to simulate a canine.

The second premolar is more constant in form than the first. This tooth often has a square-topped crown and presents an extra cusp.



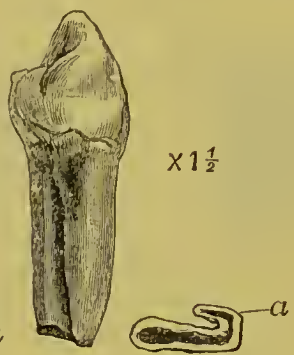


FIG. 89.[1] FIG. 90.[1]

Two human mandibular premolars, the roots of which show two stages towards complete division. (*a*) Anterior root.

FIG. 91.—First lower molar with three roots.

FIG. 92.—First lower molar with supernumerary root.

FIG. 93.—Four-rooted first lower molar.

(δ) **Molars.—The first molar** may have an extra root on the lingual aspect, situated either between the normal roots or more commonly further back when it displaces the posterior root outwards. Rarely an extra root is seen on the buccal side of the tooth

[1] From Tomes' "Dental Anatomy."

(fig. 92). Four are met with (fig. 93). The roots are occasionally fused together, and the normal backward curve may be much exaggerated. Five or even six roots are recorded, but such instances are rare; and examples of these (figs. 94 and 95) are taken from Wedl's "Atlas of Dental Pathology." (It is possible that these are examples of gemination.) Extra cusps are met with on the buccal surface.

Fig. 94.—Lower molar with five roots (Wedl).

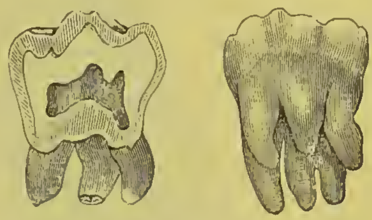


Fig. 95.—Lower molar with six roots (Wedl).

Fig. 96.

Fig. 97.

Fig. 98.—Right lower third molar, showing peculiar abnormality of the posterior external cusp.

The second molar presents abnormalities similar to the first; fusion of the roots (fig. 96), however, is more commonly seen.

The third molar presents an increased number of cusps, or the whole tooth may be reduced to a comparatively small size. The roots are often fused together and curved well backwards. At times they are grooved by the mandibular nerve, and in cases recorded, a foramen has existed for the passage of the nerve. In one variety met with the roots are fused together, while towards the apices each bifurcates, presenting four small roots (fig. 97). A peculiar abnormality of the posterior external cusp is shown in fig. 98.

(*b*) Deciduous teeth. Additional cusps and variation in the number of the roots are more rare in the deciduous than in the

permanent dentitions. The second molar, occasionally, has an additional cusp. Cases of strongly pronounced conical cusps arising from the posterior surfaces of central incisors have been recorded.

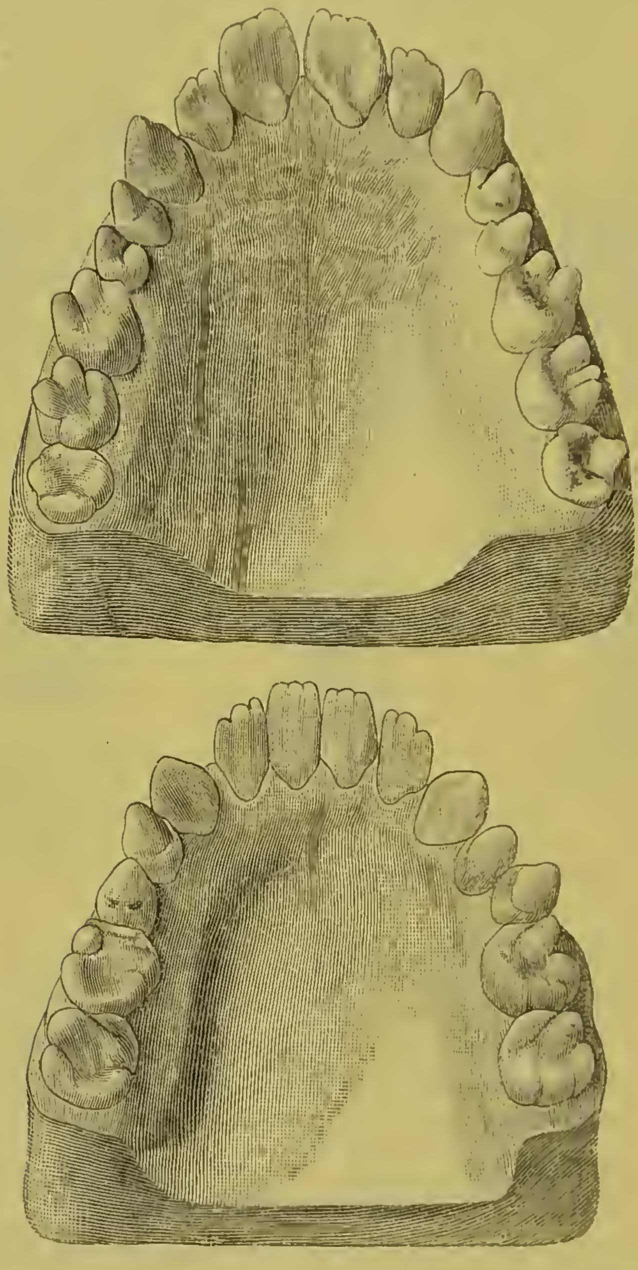


FIG. 99.

Variations in the number of the roots are found in the molar region; the maxillary second molar may have four roots and the mandibular three. Occasionally the root of the mandibular canine is bifid.

(iii.) Variations from the Normal, involving many Teeth.

A few cases of this character have been recorded. In fig. 99 is a case of this character which occurred in the practice of Mr. C. Robbins.[1]

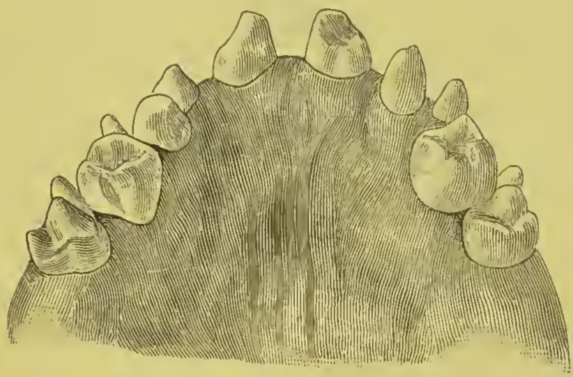


FIG. 100.

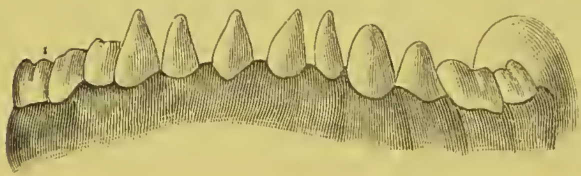


FIG. 101.

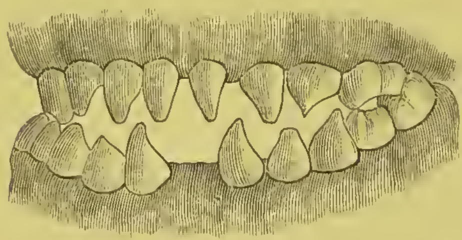


FIG. 102.

In two sisters of this patient a similar, but not so well marked, condition existed, and some cousins were also stated to have shown the same peculiarities. The models are interesting as throwing light upon the genesis of the cusps.

[1] *Transactions of the Odontological Society*, vol. xxiii., p. 80.

The remarkable abnormalities of teeth shown in figs. 100 to 102 were recorded[1] by Mr. H. Moon. The models were from the mouths of two sisters, fig. 102 being those of one aged 11 and figs. 100 and 101 one aged 15. In the younger sister the hair was short, fine and scanty. Her eyes were of a grey colour, remarkably small, the sight of the left one being defective from birth. In the elder sister the hair on the scalp was short and scanty, but very fine hairs in more than usual number were developed on the temples and cheeks. The models show that the deciduous maxillary molars are being replaced by premolars cone-like in form.

[1] *Transactions of the Odontological Society*, vol. ix., p. 232.

CHAPTER IV.

Irregularities in Position of the Teeth.

(A) CAUSES.

THE causes which produce irregularities in position of the teeth may be divided into two groups, viz., *General* and *Local*.

(1) GENERAL CAUSES.

(*a*) **Modern civilisation.**—One of the first facts which must strike any investigator into the etiology of irregularities is the comparative freedom of ancient, and even uncivilised modern races, from such defects. This has been well demonstrated by many observers; for instance, Messrs. Cartwright and Coleman failed to find any irregularities in the large collection of skulls in the crypt of Hythe Church,[1] and Dr. Nicols, quoted by Talbot, in an examination of thousands of Chinese and Indians on the Pacific Coast and in the Rocky Mountains, searched in vain for a single instance of irregularity. Dr. Talbot himself, in 1881, examined 300 Chinese and found no irregularities either in the teeth or jaws. On the other hand, Dr. J. M. Whitney[2] has found among the Hawaiians "(a people isolated from all others for at least 1,400 years, with no admixture of races), irregularity of the teeth of both maxillæ almost as common as among the mixed races of to-day." A review of facts as recorded by various writers on the question seems, however, to point to a distinct connection between irregularities and modern civilisation.

According to Talbot,[3] the early Britons possessed maxillæ

[1] The skulls, according to Hasted's "History of Kent," probably belong to the year 456. In the opinion of Mr. Pridaux, the greater portion of the skulls belong to the Celtic type, the remainder being Anglo-Saxon. Two skulls are believed to be Roman and two others Lap and Danish.

[2] *Transactions of the World's Columbrian Dental Congress*, vol. i., p. 109.

[3] "The Etiology of Osseous Deformities of the Head, Face, Jaws and Teeth," Third Edition, p. 67.

varying in their lateral diameters[1] from 2·12 to 2·62 inches, whilst in modern Englishmen the maxillæ vary from 1·88 to 2·44 inches, the minimum diameter having thus decreased more than the maximum; and a comparison of the maxillæ of Ancient Romans with modern inhabitants of Southern Italy gives a similar result. From these data he seems to infer that a diminution in the size of the jaws has taken place in the inhabitants of England and Italy, but it is not quite clear that these comparisons of the maxillæ of Ancient Britons and ourselves, and of Ancient Romans and modern Italians, are good ones. Modern Englishmen are only to a very small degree, if at all, descendants of the Ancient Britons; and similarly, the present inhabitants of Southern Italy have but little claim to direct descent from the Ancient Romans. Deductions drawn from comparisons of this kind would therefore seem to be of little value.

With the present generation, individuals from the lower social scale have, as a rule, wider maxillæ than those from the higher.

Modern civilisation probably produces these effects in the maxilla partly through the arterial system. The brain and the osseous structures of the face derive their main blood supply from the same source, viz., the common carotid arteries. The strain of modern education—indeed the whole environment of the individual—entails a greater call upon the brain than a primitive mode of living, and thus necessitates a larger supply of nutritive material to that structure. This increased supply is probably provided at the expense of the osseous structures, including the teeth, with the result that these structures degenerate.

Modern food and cooking, by calling forth less effort in mastication, may also indirectly deprive the jaws of a certain amount of nutrition.

Selective breeding in some form may have had an influence in the production of the narrow arch of the higher classes of the present day. Mr. Tomes,[2] in referring to this point says, "if the type of face nowadays considered to be beautiful be investigated, it will be found that the oval tapering face with a small mouth, &c., does not afford much room for ample dental arches. On the other

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[1] The measurements were taken from the buccal surface of one first permanent molar to the buccal surface of the corresponding tooth on the other side.

[2] "A System of Dental Surgery," Fourth Edition, p. 112.

hand, the type of face which we consider bestial has a powerful jaw development. Perhaps generation after generation seeking refinement in their wives may have unconsciously selected those whose type of face hardly allows the possibility of a regular arrangement of the full number of teeth. At any rate there is something tangible in the hypothesis and grounds for arguing pro and con."

It therefore seems probable that sexual selection and modern civilisation are factors in the production of irregularities, but one must not forget that the variation produced has been more marked in the jaws than in the teeth. The size and shape of the permanent teeth are to a great extent determined during the first two years of life. At this early stage the teeth are arranged in their crypts in a crowded condition. During the period of eruption a rapid growth of the jaws takes place in a backward direction—thus allowing the teeth to be accommodated in a normal arch—but any severe illness, such as an exanthematous fever, at this period, may lead to an arrest of the development of the body, including the maxilla and mandible, and in this way a crowded arrangement of the teeth may be produced.

(*b*) **Heredity.**—Certain irregularities of the teeth and jaws are undoubtedly transmitted from one generation to another, and indeed not infrequently become family peculiarities. A slight overlapping of the centrals, not the result of crowding, may sometimes be traced in the parents and in the children, and in one case which has come under observation the right incisors slightly overlapped the left in the father and in four of the children out of a family of seven. Prominent upper teeth accompanied by a small maxilla, or large mandible, are often transmitted through many generations.

(*c*) **Race crossing.**—Dr. Talbot is of the opinion that an explanation of some irregularities can be found in "race crossing." Every nation has its own peculiar characteristics, which manifest themselves in "the head and skeleton, the general contour and mould of the body, the manners, &c.," and the older the race the more fixed these characteristics become. One race may possess large jaws and equally large teeth, another small jaws and proportionally small teeth, and it is quite conceivable that intermarriage between two such races would lead to irregularities in the jaws and teeth of the offspring. Dr. Talbot, in dealing with this subject, points out that in mixed races such as the Americans, irregularities are prevalent, while in purer races such as the Chinese

and African, irregularities are seldom met with. On the other hand, the presence of irregularities in the Hawaiians must not be lost sight of. Mr. J. R. Headridge[1] considers that this view is untenable, and he instances that in dogs, where cross-breeds between parents of very different sizes are frequent, irregularities are very rare.

In practice one certainly meets with cases where one parent has large teeth and jaws, and the other small teeth and small jaws, the offspring inheriting the large teeth of one parent and the small jaws of the other. That intermarriage of races plays a part in the production of some irregularities seems extremely probable. The question, however, demands a more thorough investigation than has yet been accorded to it.

(*d*) **Irregularities of the teeth** are said by Talbot to be more frequent in people **congenitally deaf, dumb or blind.**

(2) LOCAL CAUSES.

(*a*) **Premature removal of teeth.**—Premature removal of the second deciduous molar is a fruitful cause of crowding. Removal of this tooth at an early age allows the first permanent molar to move forward and so encroach upon the space which would be occupied normally by the second premolar.

Premature removal of the deciduous canines may lead to irregularities by allowing the first premolars and lateral incisors to erupt irregularly. Under certain conditions removal of the deciduous canines to relieve a crowded arrangement of the incisors is advisable, but this subject will be more fully discussed wheu dealing with the treatment of crowded mouths.

Under certain conditions, the early extraction of the first permanent molars may produce irregularity. In cases where the deciduous molars are very carious, the first permanent molars are practically the sole means by which mastication is carried on, and their early removal under such circumstances would transfer the whole force of the bite to the incisors, with the probable result that the upper ones would be driven forward—an irregularity at times difficult to remedy.

[1] *British Journal of Dental Science*, vol. xxvii., p. 145.

(*b*) **Persistence of deciduous teeth.** — The loss of the deciduous teeth is, under normal conditions, due to absorption of their roots. Absorption is brought about by the action of the "absorbent organ," which is a mass of cells possessing osteoclastic and probably phagocytic properties. The stimulus calling into existence this mass of cells is the erupting permanent tooth. Under normal conditions the whole of the root of the deciduous tooth lies in the line of eruption of the permanent tooth, and absorption gradually proceeds until the entire root is removed. The crown falls away and its place is taken by the permanent tooth. If from some cause, such as crowding, the erupting tooth does not take its normal line,

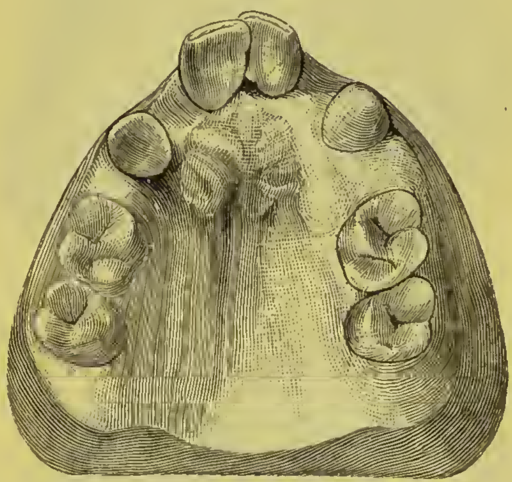

FIG. 103.—Showing the result of premature removal of the premolars.

only that portion of the deciduous root which lies in its course is absorbed.

Deciduous teeth which are pulpless or necrosed undergo little absorption. Such teeth obstruct the movement of the erupting tooth, deflect it from its course, and so cause it to erupt in an irregular position.

Cases of irregular permanent teeth in which the deciduous teeth are still present are therefore due to :—

(i.) The original mal-direction of the erupting tooth.

(ii.) The presence of necrosed or pulpless deciduous teeth.

(*c*) **Mouth breathing** is held by many to be an active factor in the production of maxillary deformities, and the frequent association of chronic nasal obstruction with the high vaulted palate would

seem to indicate the possibility of a connection existing between the two. In an interesting paper to the *West London Medical Journal* (July, 1896) Mr. Mayo Collier states that if one nostril be blocked up, the rush of air passing under the naso-pharynx and to some extent through the open half of the nasal cavity, lessens the tension in the closed portion of that cavity. This can

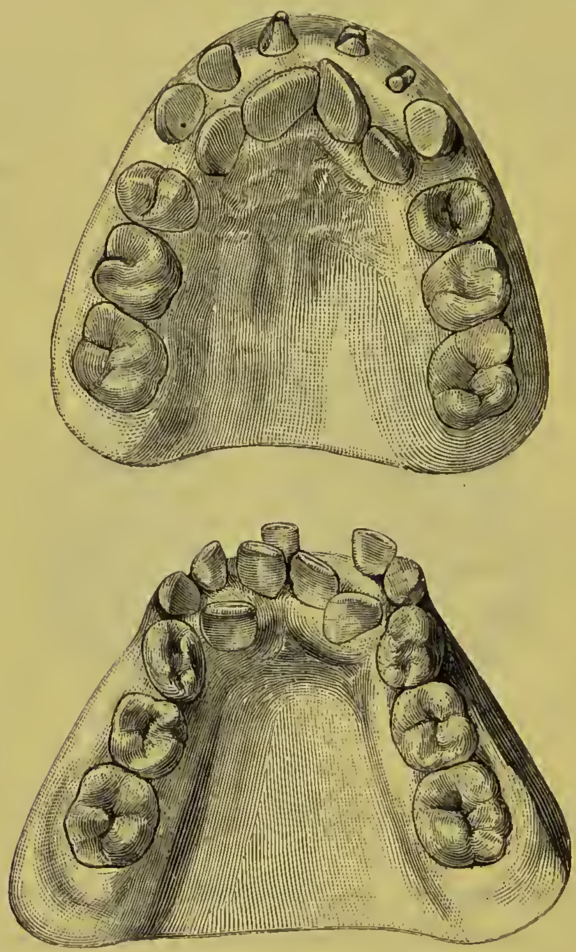

FIG. 104.—A case of irregularity accompanied by permanent deciduous teeth.

be shown by the following simple experiment: Take a bent piece of glass with mercury in the bend, connect one arm with a fairly thick elastic tube and insert the latter into the blocked nostril. During every inspiration the mercury will fall in one limb and rise in the other to the extent of an inch or more, and this, according to the author, is equal to the pressure of about half a pound on

every square inch. In other words, if each nasal cavity is regarded as a box, it means that in cases of nasal obstruction during each inspiration there is a force equal to half a pound on every square inch of the bones forming the fossa, and it is possible to conceive

FIG. 105.

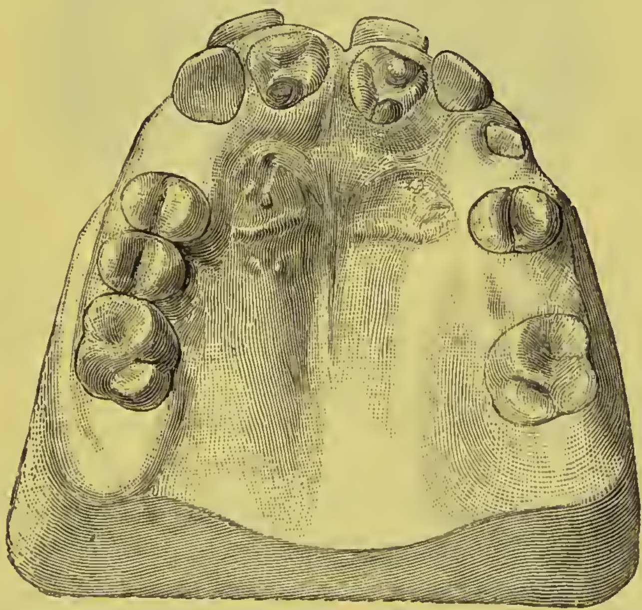

FIG. 106.

that such a force would produce the contracted and high arched palate so often seen.

This view is corroborated by an experiment made by Ziem and quoted by Mr. Mayo Collier. Ziem artificially blocked the nostril of a young animal for a long time, with the result that he noticed

"there was a deviation of the intermaxillary bone and the sagittal suture towards the shut up side, also lesser length of the nasal bone, frontal bone, and horizontal plate of the palate bone, less steep elevation of the alveolar process, smaller distances between the anterior surface of the bony auditory capsule and the alveolar processes, and also between the zygomatic arch and the supra-orbital borders—in other words, the whole side of the face was squeezed in from all points by the unequilibrated atmospheric

FIG. 107.

pressure due to the rarefication of the air from within the obstructed nasal fossa, with a result that the whole side of the head was prevented from expanding and growing."

(*d*) **Supernumerary teeth** often cause irregularities. A divergence of the upper central incisors is at times due to the presence of a supernumerary tooth, usually peg-shaped. An example of this is shown in fig. 105. Displacement of the incisors internal or external to the arch, or a general crowding of the teeth may occasionally be traced to the presence of supernumerary teeth. Examples are shown in figs. 106, 107 and 108.

(*e*) **Habits.**—The habit of sucking the thumb, lip, tongue or toe produces irregularities. A consideration of this group of causes will be found in the chapter dealing with superior protrusion.

(*f*) **The frænum of the lip** at times passes between the central incisors and is attached to the muco-periosteum covering the palate.

Under such conditions every movement of the lip causes the frænum to press on the teeth and thus separates them. This cause of divergent centrals was first pointed out by Mr. H. Moon.

(*g*) **Alveolar abscess** in connection with the deciduous teeth sometimes leads to irregularity in position of permanent ones, while **cicatrices, hypertrophy of the gums,** in addition to **injuries, malformation and tumours of the jaws** may be also cited as local causes.

FIG. 108.

(B) GENERAL POINTS IN TREATMENT.

(*a*) **Careful supervision of the mouth** during the period of the second dentition will do much to prevent or, at least, to simplify irregularities.

The early treatment of caries in the deciduous molars will often prevent their premature loss, while the timely removal of a deciduous tooth will often prevent a permanent one from assuming an abnormal position. Special attention should be bestowed upon the first permanent molars. Any cavities which appear should immediately be filled. If the distal aspect of the second deciduous molar be carious, attention must be given to prevent food lodging against the first permanent molar, as this would imperil the latter tooth. If caries does appear on the anterior surface of the permanent molar, the advisability of removing the deciduous tooth and making the surface of the permanent molar self-cleansing must be con-

sidered. The successful preservation of the first permanent molar far outweighs the slight moving forward of the tooth which would result from the removal of the second deciduous molar. To secure good results children's teeth should be examined at least three times a year, and the necessity for constant supervision should be impressed on the parents.

In any case where there is a question as to the best method of treatment it is advisable to take **models of the mouth**, to be studied in connection with a chart on which the condition of the teeth has been carefully noted. In this way points often become apparent which would be missed by a mere examination of the mouth. In cases coming under observation at an early stage it is advisable to take models periodically, so that the development of the mouth can be watched and perhaps some light gained as to the best method to pursue in the treatment.

(*b*) **The sex of the patient** influences the treatment from an æsthetic point of view, as the correction of an irregularity is more important to a woman than to a man.

(*c*) **The age of the patient** is also important, as the difficulty of moving and retaining the teeth in a new position increases with the age. As a rule it is not advisable to attempt correction of irregular teeth by mechanical means in adults. The older the patient the more difficult the teeth are to move and retain in a new position. Again, the older the patient the greater the danger of starting pathological changes in the periodontal membrane.

(*d*) **The question of heredity** must also be borne in mind. An irregularity which is hereditary is, as a rule, obstinate to correct.

(*e*) **The general health and temperament** of the patient will often influence one's decision. In weak, nervous children mechanical treatment should if possible be avoided for obvious reasons.

(*f*) **Co-operation of parents and patients.**—In all cases requiring mechanical treatment the thorough co-operation of parents and patients is most essential. Regulating apparatus, unless constantly worn and properly attended to, does much more harm than good. If the practitioner has reason to believe that his instructions will not be faithfully carried out, prolonged mechanical treatment should be avoided.

(*g*) **The facial expression and type of face** must be considered in relation to the irregularity. For example :—

A narrow arch may be accompanied by a narrow face with a

small mouth and correspondingly small features, all of which are in harmony. Expansion or spreading of the arch under such conditions might mar the character of the face.

The removal of the canine usually produces an ugly flatness of the upper lip and allows the angles of the nose to sink.

In cases where, with protrusion of the upper teeth, the lower lip is unduly flat, but the lower teeth are crowded, with perhaps the canines slightly prominent, an attempt to regulate the canines by bringing them into line will tend to increase the flatness of the lower lip and to accentuate the protrusion of the upper teeth.

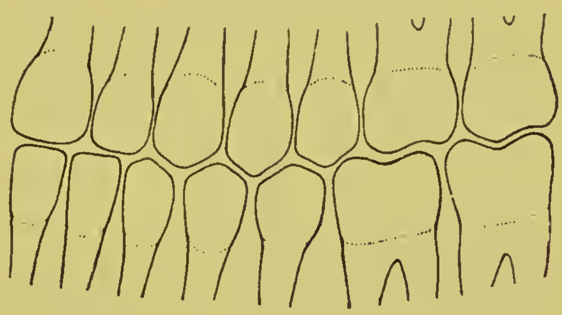

FIG. 109.

(*h*) **Examination of the teeth.**—The teeth must be carefully examined and the following points determined :—

(i.) The general character of the teeth.

(ii.) The presence and extent of caries, especially on the approximal surfaces.

(iii.) The directions of the roots of the teeth. (The value of this point will be referred to in a subsequent chapter.)

(iv.) The occlusion of the teeth.

(v.) The general condition of the gums. In a patient showing a tendency to chronic inflammation, mechanical treatment is not desirable.

(*i.*) **Travelling of the teeth.**—The tendency of teeth to shift their positions in the mouth is sometimes termed "**travelling of the teeth.**" In this natural movement the "bite" or occlusion of the teeth is an important factor. If a normal articulation (fig. 109) be examined it will be observed that the opposing teeth present inclined planes to one another, and this is particularly noticeable in the premolar region. In each act of mastication pressure is brought

to bear upon these surfaces, and as long as the resistance remains equal in all directions the tooth retains its position. Remove this resistance, wholly or in part, and the force exerted by the muscles will in each act of mastication tend to drive the teeth in the direction of least resistance. Take, as an example, the case diagrammatically illustrated in fig. 110. The first molars have been removed. Each time the posterior plane of the second lower premolar strikes the anterior plane of the second upper premolar the tendency will be to drive the latter tooth in the direction of least resistance, namely, backwards. When once this tooth has travelled backwards the resistance to the movement of the second

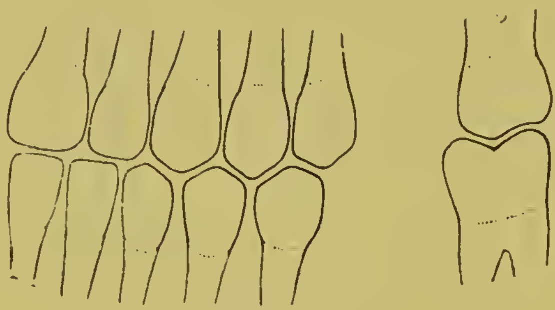

FIG. 110.

lower premolar in the posterior direction is removed, so that the force of the posterior plane of the first upper premolar striking the anterior plane of the lower second premolar will tend to drive the latter also in a backward direction. In like manner the posterior plane of the first lower premolar will tend to drive back the first upper premolar. In addition to the power derived from the muscles of mastication, the force exerted by the lips, tongue, and the process of eruption are important factors in producing the natural movement of teeth. The lips exert force in a backward direction, the tongue in a forward direction. When employing extraction for the correction of an irregularity, an endeavour should be made to "unlock" the bite. This will be more easily understood by a reference to fig. 111. For the sake of argument we will suppose that the canine has erupted externally to the arch. To provide space the first upper molar only is removed. The bite will remain locked; in other words, the second premolar will require mechanical means to train it in a backward direction, and even then will occlude with

the molar—an unsatisfactory condition. Mechanical means will also be required to retract the first premolar. If the lower first molar is removed as well as the upper, mechanical methods can be to a very great extent avoided, and the bite will be less disarranged.

When removing teeth in both maxilla and mandible, opposing teeth should if possible be selected. A glance at the diagram

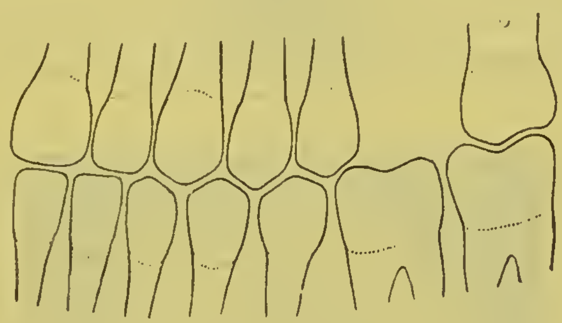

FIG. 111.

(fig. 112) will show the disadvantage of not following this course. In the upper the first molar has been removed, and in the lower the second premolar. There is considerable destruction of the masticating area, and moreover mechanical methods must be used to retract the teeth. Removal of the upper and lower second premolars, or

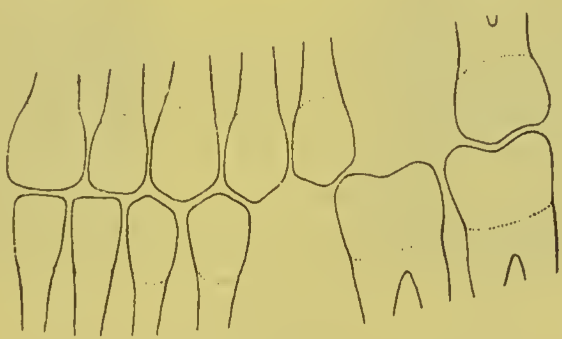

FIG. 112.

the upper and lower first molars, would have interfered far less with the masticating area, and would have unlocked the bite and allowed the teeth to travel backwards unaided by mechanical means.

(*j*) The relation of the teeth to the median line of the face should be remembered in employing extraction, although the importance of this point is sometimes a little overrated. In the case of girls,

any deviation to one side or the other in the direction of the incisors causes an appreciable disfigurement. The centre of the mouth is likely to shift when the bite is unlocked on one side and not on the other. Take, as an example, a case where it has been necessary to remove the first upper premolar on the left side. The posterior resistance to the canine and lateral is removed, with the result that the force of the lip tends to drive all the anterior teeth to that side, and so causes the centre to shift. An example of this is shown in fig. 113. The patient's appearance has suffered considerably.

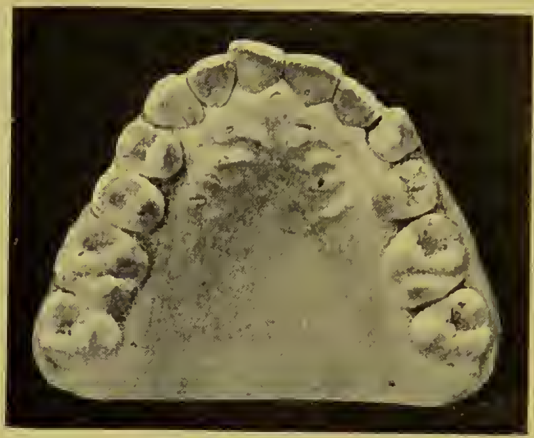

FIG. 113.

Removal of the first right upper premolar as well as the first left upper premolar would have prevented this, because the posterior resistance on both sides being removed, the lips would have forced the anterior teeth back equally on both sides.

Removal of one second upper premolar will not cause the centre to shift, because the bite will be locked by the first upper premolar occluding with the lower premolars, but removal of the fellow tooth in the lower will remove the posterior resistance and permit the first premolars—upper and lower—to shift back, and so produce an alteration in the centre of the mouth. Other examples could be quoted. Removal of the first upper and lower right molars and the first upper left molar would cause the centre to shift towards the right side, because the bite is locked on one side and not on the other.

(*k*) **Skiagrams of the teeth** will be found most useful in cases where doubt exists as to the directions of the roots of teeth, or the

presence or absence of unerupted teeth. The following cases will serve to illustrate the value of the X-rays as an aid to diagnosis in irregularities.

In the case shown in fig. 114 the skiagram was taken for the

Fig. 114.

purpose of ascertaining the cause of the separation of the upper central incisors. The skiagram shows the presence of a peg-shaped supernumerary tooth, and also defines its direction.

The skiagram shown in fig. 115 was taken to determine the relation of the permanent canine to the permanent lateral, the latter tooth having erupted in an irregular position. The position of the permanent canine is clearly shown, and indicates that the first premolar should be removed to allow room and so relieve the pressure on the lateral incisor.

Fig. 115.

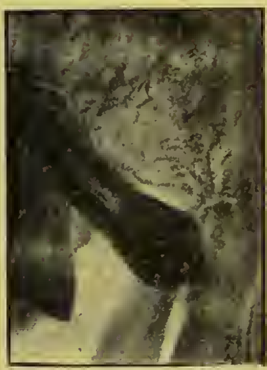

Fig. 116.

Fig. 116 was taken to ascertain the position of an unerupted canine. There was a slight bulging on the palatal aspect of the alveolus, indicating the presence of the canine, but the space between the lateral incisor and first premolar was insufficient. If the canine were in good position, removal of the first premolar would be indicated. The skiagram, however, shows that the canine is lying nearly horizontal, and that there is but little chance of its erupting in correct position.

(C) THE MOVEMENT OF TEETH BY MECHANICAL APPLIANCES.

(1) REGULATING APPLIANCES.

The movement of teeth by mechanical means is accomplished by the use of certain forces acting from a fixed base known as "the point of delivery." The resistance of the point of delivery or anchorage must be greater than that of the tooth or teeth to be moved. This is essential, and is frequently overlooked.

The point of delivery is usually obtained from the resistance of teeth either by means of a well-fitting plate or by embracing two or more teeth with a clamp or band, the force to be used being attached to the plate or band as the case may be. In a few forms of apparatus the occiput is utilised as the point of delivery. Regulating appliances are thus divisible into two main groups: (*a*) removable, (*b*) fixed.

(*a*) **Removable appliances.**—Formerly gold or dental alloy was used in the manufacture of the plate, but vulcanite has now almost entirely superseded the metals. With vulcanite a much better fit can be obtained, and the bite can be more easily adjusted.

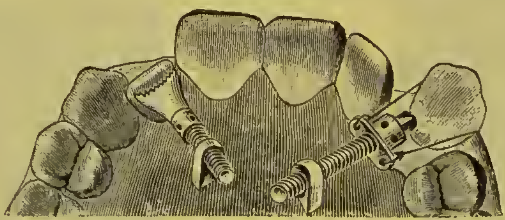

FIG. 117.

The successful working of a regulation plate depends mainly upon the fit, and great care should therefore be taken in obtaining models of the mouth. The back teeth should usually be capped, as the real point of delivery is obtained from the teeth, and by capping them a much firmer hold can be obtained.

All plates must be carefully adjusted to the bite of the opposing teeth. The plate should be tried in the mouth and the bite adjusted by the aid of a proper articulator. It is well to allow the lower teeth to bite "well home" into the vulcanite. In this way the plate is kept more firmly in position, and when the mouth is closed the lower teeth also act as part of the point of delivery.

The forces employed for moving teeth.—(i.) **The screw** is perhaps the most powerful. Its most useful application is in cases where considerable resistance has to be overcome, *e.g.*, when a maxillary canine has erupted internal to the arch. The jackscrew finds most favour, and the mode of using it is shown in fig. 117.

The screw must be adjusted at regular fixed intervals, only a slight degree of force being applied at each visit. The force exerted by a screw is not continuous, but this is evidently no disadvantage, as the results obtained from screw force in regulating teeth are entirely satisfactory.

(ii.) **The wedge.**—**Hickory wood** compressed laterally is mostly used. The saliva moistens the wood, causing it to expand and so exert force. In using wooden wedges the grain of the wood should lie parallel to the direction in which it is proposed to move the tooth. The wedge will be found most useful in forcing incisors forward. The method of adjusting the wooden wedge is shown in fig. 118.

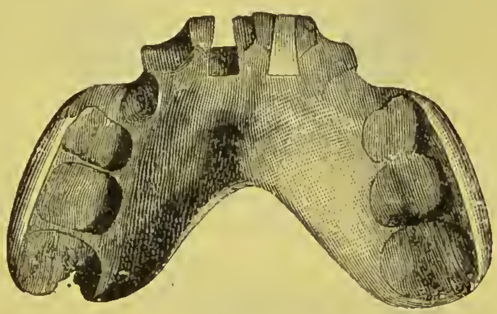

FIG. 118.

A double dove-tailed slot is cut in the vulcanite plate, one broad end being away from the tooth, the other being towards the palatal aspect of the plate. Into this slot the hickory wedge is placed. For forcing the premolars backwards wedges of hickory wood are also useful.

Wedges of rubber may also be used. Cone-shaped holes are drilled in the plate, the base of the cone being towards the tooth to be moved. A loop of rubber is fixed in each hole, the free ends passing through the apical portion of the cone on the palatal surface. Rubber makes a more powerful wedge than hickory wood, but its action is not so gradual, and it is more likely to cause pain by forcing the teeth forward too quickly.

Wedging may be carried out by the aid of vulcanite pegs. Cone-shaped holes are drilled in the plate, and in place of the rubber a vulcanite peg is inserted and is left sufficiently long to prevent the plate being forced at once into place. The peg is also arranged with a sloping surface so that at first it presses on the tooth near the cutting edge, and as the plate is driven up into place by the lower teeth so the tooth is forced forward. It is important that the lower incisors should occlude with the plate and so increase the force transmitted to the teeth to be moved.

(iii.) **The inclined plane** is most usefully employed when it is necessary to force forward three or four upper incisors. For this purpose a plate is made capping the lower teeth, and to this an inclined plane is fixed so that when the mouth is closed the teeth to be moved impinge on the sloping surface and are thus driven forward. The inclined plane must be used with care, as it may force the teeth forward too quickly and set up inflammation.

FIG. 119.—Lower plate, with inclined plane on right side, used for pushing out a maxillary canine.

(iv.) **Elasticity.**—The force obtained from the elastic properties both of rubber and metals, especially the latter, is most useful for mechanical regulation of teeth.

(α) *Rubber.*—This material is generally used in the form of small bands. There is always some difficulty in retaining the bands in position on the teeth, the tendency being for them to slip towards the neck and cause inflammation. This can be overcome by cementing to the teeth metal bands with hooks attached. The rubber bands require frequent renewal and are somewhat uncertain in their action. (Rubber in the form of wedges has already been referred to.)

(β) *Pianoforte wire.*—This is a most useful material. It is light, strong, inexpensive and capable, in skilful hands, of being utilised to produce any movement, *i.e.*, pulsion, traction, or torsion of a tooth, and moreover it is constant in its action and can be easily con-

trolled. The wire used should be thin (gauges No. 14 to 17). The disadvantage of the wire is the tendency to oxidise in the vulcaniser, but this can be overcome by tinning the wire. The following method is suggested by Mr. Coysh (*Dental Record*, vol. xi., p. 109): —"After cleaning the wire thoroughly it is dipped into chloride of

FIG. 120.

FIG. 121.

zinc solution, and then for an instant into melted tin which must not be too hot and the surface of which must be quite clear. Upon removal from this the surplus molten tin is quickly shaken off and the spring cooled in cold water."

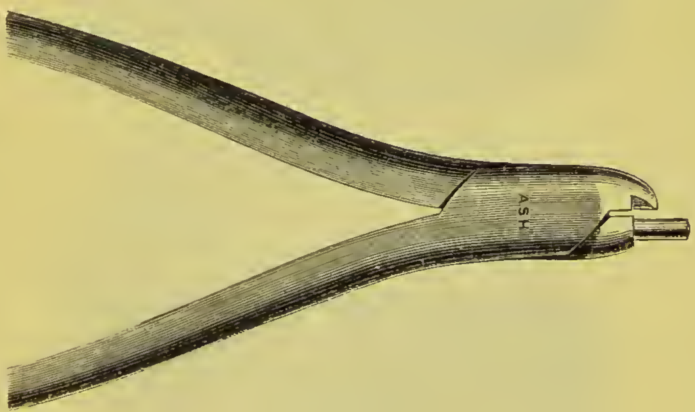

FIG. 122.

Pianoforte wire is used to the best advantage when curved or coiled; in this way greater springiness is obtained. The twist given may be similar to that shown in fig. 120, or to that seen in fig. 121.

For the manipulation of pianoforte wire the pliers designed by Mr. Northcroft and shown in fig. 122 will be found most useful. In twisting up the wire, anything approaching an angular bend must

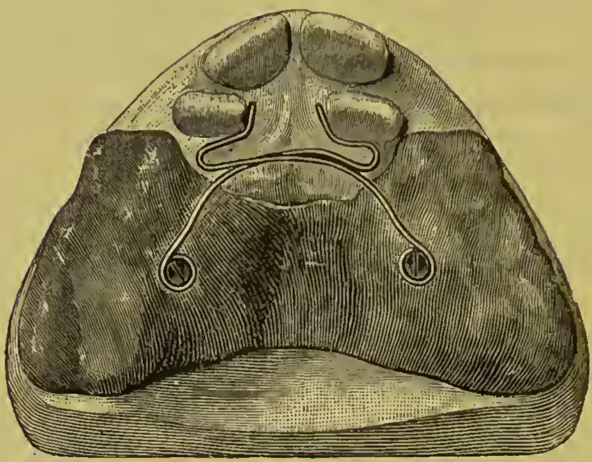

FIG 123.—Plate for pushing outwards and rotating lateral incisors.

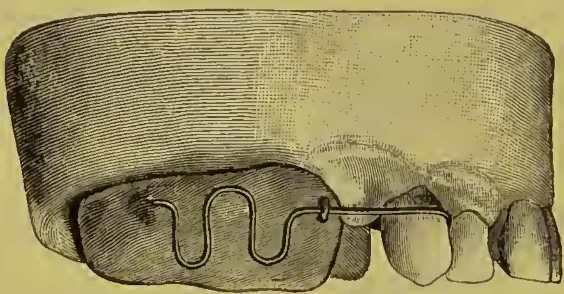

FIG. 124.—Plate for retracting a canine.

FIG. 125.—Plate for rotating a maxillary central incisor.

be avoided. Care must be taken to arrange that the direction of the force of the spring is similar to that in which the tooth is to be moved. A bend should be made in the wire at the free end where it impinges on the tooth. This will permit the wire to be more easily adjusted in the direction required. It is also important that the coil or turn which gives the spring and the direction of force required should be in parallel planes. In the figures (123 to 130) some methods of employing pianoforte wire are shown.

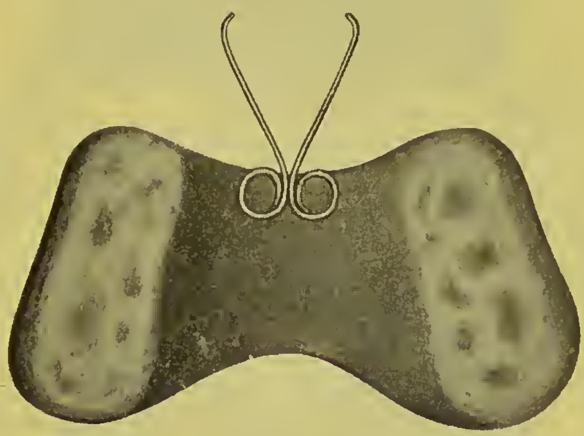

FIG. 126.—Plate for drawing together central incisors.

FIG. 127.—Plate for pushing the distal side of a maxillary central over the mandibular teeth, and at the same time slightly rotating it.

(γ) *Gold wire* can be used in place of pianoforte wire for regulating. It may be made fairly springy by gentle hammering, but the peculiar elasticity of the steel wire cannot be obtained. Gold wire is neater in appearance, does not stain the teeth and does not oxidise.

FIG. 128.—Plate for retracting premolars.

FIG. 129.—Plate for pushing forward an upper incisor.

FIG. 130.—Plate for retaining the teeth in position after regulation.

(*b*) **Fixed apparatus.**—With fixed forms of apparatus the "point of delivery" is obtained by banding two or more of the posterior teeth, and fixing to the band the force to be employed. The bands should always be fastened to the teeth with oxy-phosphate cement.

FIG. 131.

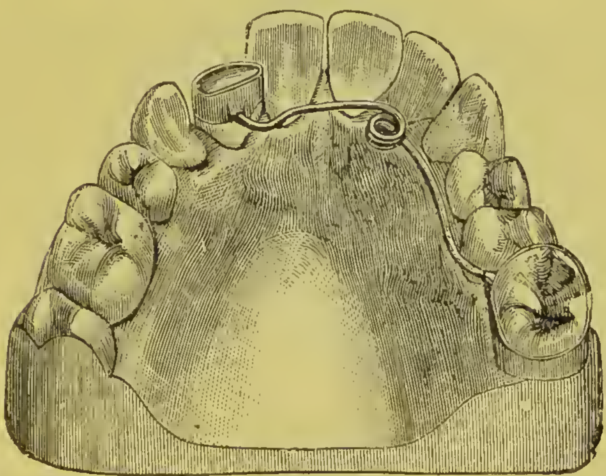

FIG. 132.[1]

Various forms of fixed regulating apparatus are shown in the following illustrations.

In fig. 131 is seen a method (Angle's) for moving a lateral incisor in an outward direction by means of a jack screw. The

[1] From "Text-Book of Operative Dentistry" (Kirk).

tooth chosen as anchorage is as nearly as possible in a direct line with the movement desired to be given to the lateral incisor.

A method of employing pianoforte wire is shown in fig. 132. The twist given to the wire is generally known as "Talbot's coil."

Fig. 133 shows a method suggested by Angle for retracting a canine. The anchorage tooth and the tooth to be moved are banded. The two bands are connected by a traction screw.

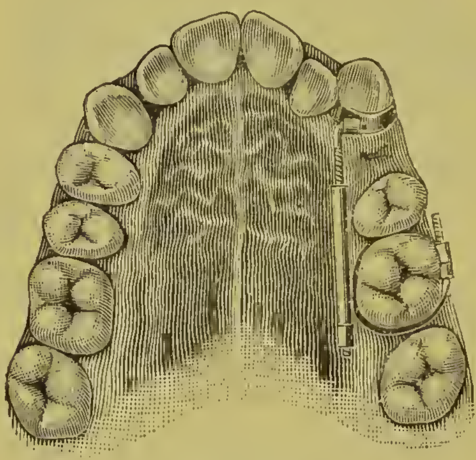

FIG. 133.

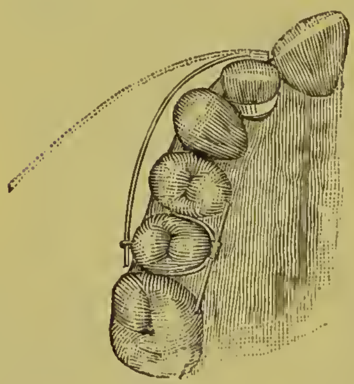

FIG. 134.

A method of producing rotation, also from Angle, is shown in fig. 134. The tooth to be rotated is banded. Anchorage is obtained from the second premolar, the resistance being increased by the bar shown in the figure. The teeth are then connected by pianoforte wire.

A method of moving forward incisor teeth, designed by Goddard, is shown in fig. 135. The first molars are banded, and to the bands

tubes are attached into which pianoforte wires are inserted. The wires are bent to conform to the arch of the teeth, and their free ends are inserted into tubes on the labial surfaces of bands cemented on the teeth to be moved.

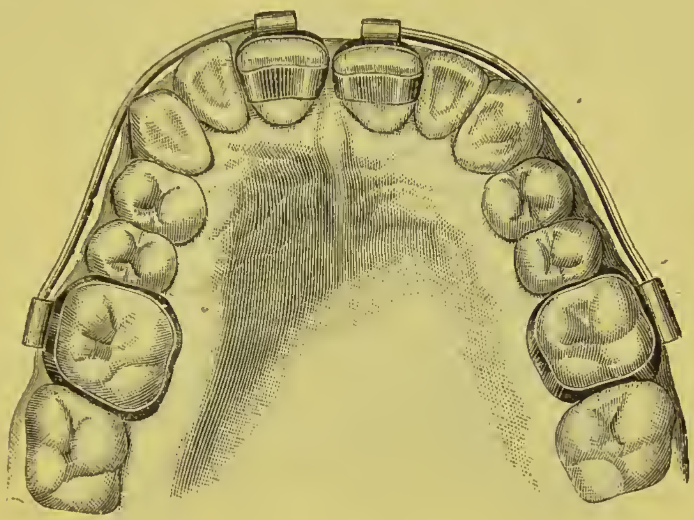

FIG. 135.[1]

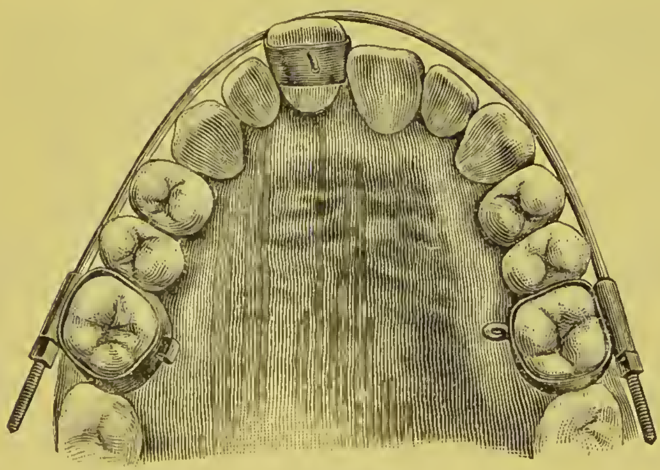

FIG. 136.[2]

A method of retracting a central incisor is shown in fig. 136.

A method of regulating devised by Angle is shown in fig. 137. In this case the tooth to be rotated and pushed forward is banded, a tube being soldered to it at the mesio-lingual angle. A piece of

[1] From "Text-Book of Prosthetic Dentistry" (Essig).
[2] From "Text-Book of Operative Dentistry" (Kirk).

wire is inserted into the tube, the other end being secured in a pit made in the deciduous molar. The wire is occasionally pinched with pliers and in this way lengthened and the tooth moved in the required direction. This method is ingenious, but equally good results can be obtained more easily. The apparatus shown in fig. 138 is also from Angle, and shows a method of retracting a

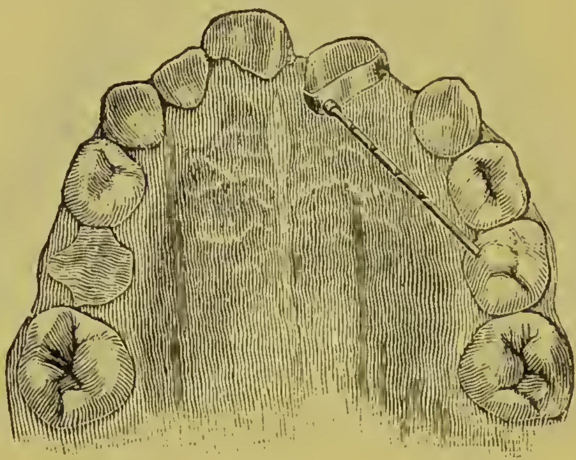

Fig. 137.

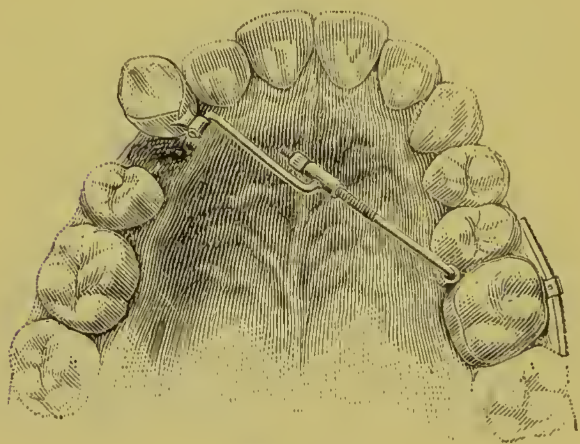

Fig. 138.

right canine. The left first molar is banded and the anchorage strengthened by attaching to the buccal side of the band a wire which rests on the buccal aspects of the approximal teeth. The right canine is banded and connected with the molar by means of a jack screw.

Those interested in fixed appliances should refer to the works of Farrar, Angle, Talbot and Guildford.

(2) CHANGES IN THE TISSUES PRODUCED BY MECHANICAL MOVEMENT.

The position which a tooth assumes when acted upon by mechanical appliances depends largely upon the manner in which force is applied.

With the majority of appliances a movement similar to that shown in fig. 139 takes place. The force P, which is applied to the

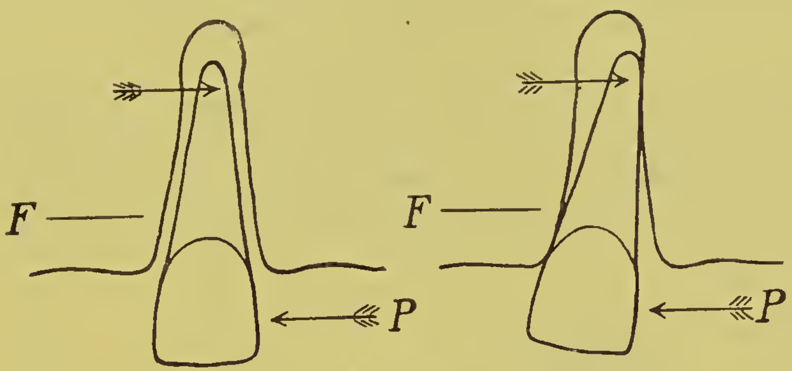

Fig. 139.

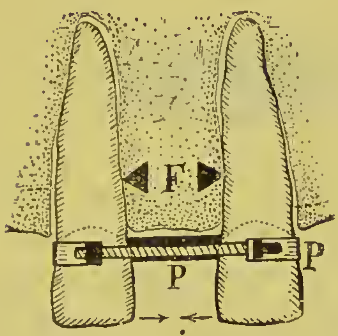

Fig. 140. (Farrar).

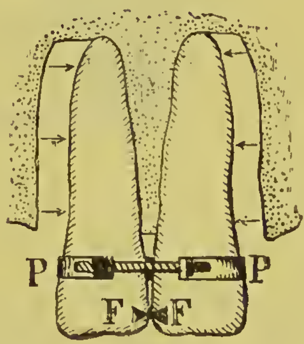

Fig. 141. (Farrar).

crown, is transmitted to the opposing portion of the alveolus F, and in proportion to the resistance here met with, the apex is moved in the opposite direction. The movement of the apex is probably but slight, and for practical purposes the tooth may be said to move in the arc of a circle, the centre of which is represented by the apex of the tooth.

Under certain conditions it is possible to apply force so as to move both crown and apex in the same direction. The diagrams (figs. 140 and 141) illustrate one method by which this movement

may be produced. If a clamp band is attached to two separated central incisors the immediate result of applying force will be to approximate the mesial angles and cause the apical portions of the roots to diverge. When the mesial angles come into contact the fulcrum will be shifted from the alveolus to the point of contact in the crowns, and the continued application of force will cause the teeth to approximate throughout their whole length until they become parallel (see fig. 141). It will be noticed that whilst the alveolar process forms the point of resistance the apices tend to move in directions reverse to the crowns, but directly the fulcrum is transferred to the crowns the apices commence to approximate. This creation of a static fulcrum on some portion of the crown near the occluding surface, and the application of force as high up on the tooth as possible, are the fundamental principles underlying all appliances which claim to move the roots of the teeth bodily.

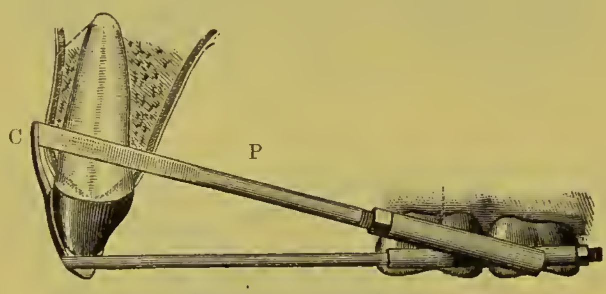

FIG. 142.[1]

The method introduced by Dr. Case, of Chicago, is ingenious. The tooth is banded and to the band an upright bar, C, is soldered (see fig. 142). To the lower end of C a traction bar, F, is fixed, this bar being united to the point of delivery. Force is applied by connecting the upper part of the bar C with the point of delivery by means of a bar P. By adjusting the screws connected with the bars P and F the root or the entire tooth can be moved backwards or forwards as required.

When pressure is applied to a tooth the alveolar wall, against which the pressure is indirectly applied, undergoes absorption, and when the tooth has been moved into the position required, and is

[1] From "Text-Book of Operative Dentistry" (Kirk).

retained there firmly by suitable means, a fresh deposition of bone takes place and a new socket is formed. The rapidity with which this fresh bone is deposited depends upon (1) the recuperative powers of the patient; (2) the retention or non-retention of the tooth firmly in its new position by suitable means during the period the tissue is forming; (3) the amount of local disturbance caused by the operation.

(3) COMPLICATIONS AND SEQUELÆ OF MECHANICAL MOVEMENT OF THE TEETH.

The mechanical regulation of teeth may be attended by certain complications or sequelæ.

(*a*) **Periodontitis.**—Inflammation of the periodontal membrane may result from the application of too great a force to the tooth or from direct impingement of the force on the membrane through faulty adjustment. The inflammation of the periodontal membrane may spread to the pulp and so cause its death. Chronic periodontitis frequently attacks teeth which have been regulated. The changes which occur during regulation may tend to lower the vitality of the tissues, and so render them liable to attack.

(*b*) **Caries.**—This is to a great extent an avoidable sequela. The more clean the apparatus and mouth are kept the less will be the liability to caries. The movable types of apparatus have in this respect a strong advantage over the fixed ones. The mouth and all mechanical appliances must be carefully cleaned after every meal. Previously to inserting the plate an alkaline mouth wash[1] should be used, and it is also well to run a little of the fluid over the surface of the plate where it comes in contact with the teeth and gums.

(*c*) **Permanent enlargement of the alveoli.**—This condition is due to insufficient re-formation of bone after the tooth has assumed its new position. There may be a lack of recuperative power on the

[1] The following is suggested:—

℞ Mag. Carb. Levis ... ... ʒ iv.
Aq. Rosæ ... ... ℥ vi.
Aquam. ad ... ... ℥ xii.
M. Shake before using.

After the mouth has been thoroughly cleansed, a teaspoonful is to be taken and floated about in the mouth between the teeth. The magnesia, which is only in suspension, clings about the necks of the teeth and neutralises any acid. Ordinary solutions of alkalies have only a transient effect upon the oral secretions.

part of the individual from general causes. Growing tissues are more likely to recuperate than fully developed ones, hence the frequency to permanent enlargement of the alveoli in cases of regulation in adults. The enlargement of the alveoli may be the result of inflammatory changes in the tissues due to want of care in regulating. Teeth which have been moved should be retained firmly in their new position, otherwise permanent enlargement of the alveoli may result from undue movement in the socket.

(*d*) **Inflammation of the gums.**—In cases where the regulation has been too rapidly carried out inflammation of the gums frequently occurs. It may also arise from want of care in cleansing the plate. The application of a little tincture of iodine, powdered tannic acid or some other suitable astringent will speedily remove the trouble. If, however, the inflammation increases, the application of force must be postponed until the gums return to a normal condition.

(*e*) **Sloughing of the gums.**—This condition is rare, and is generally due to allowing the plate to press on the gums and not on the teeth. When it occurs the plate must be immediately abandoned and must not be used again until the tissues have assumed a healthy condition.

(D) THE MOVEMENT OF TEETH BY SURGICAL METHODS.

The operation of "torsion" has long been in vogue. Within the last few years the immediate regulation of teeth has been considerably extended.

In a communication to the Odontological Society,[1] Mr. Sidney Spokes showed some cases of instanding incisors and canines which he had treated by immediate methods. The method pursued is as follows. The deciduous teeth are extracted and their permanent successors are then grasped with forceps and forcibly advanced over the edges of the lower teeth. Where there are neighbouring teeth a silver wire interlaced is sufficient to hold the advanced tooth in its new position. In the ten cases shown, four centrals and six laterals had been regulated and were in good positions.

When last seen by Mr. Spokes the pulps in every instance had responded to the thermal test. Of three cases of canines treated

[1] Vol. xxvii., p. 180.

only one was a success. The accidents which may occur are (1) loss of the permanent tooth through injury to its pulp, or by unintentional extraction; (2) fracture of portion of the tooth.

Dr. Bryan adopts a different method. He suggests that in a case similar to that shown in fig. 143 it would be well to take

FIG. 143.

a model of the case and saw through the plaster cast as one does through the jaw to be regulated. This section should be broken out as far up as the root of the tooth goes, and fitted and secured with the crown in the place it will occupy when in line and properly articulated with the lower teeth. This done, a wax plate should be fitted over the whole palate. From the wax a space should be cut out sufficient to accommodate the inner blade of the forceps.

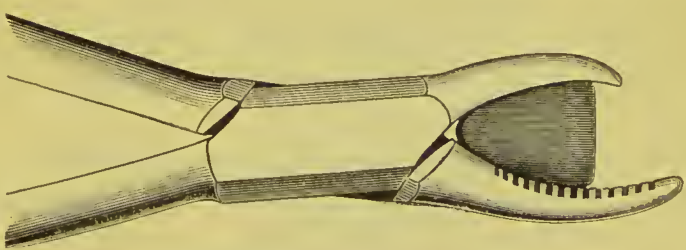

FIG. 144.

The forceps should then be placed in the position they will occupy during the operation, and a depression (*a*) forced in the wax with the outer blade of the forceps. This depression will prevent the outer blade slipping during the operation. The vulcanite at this part should also be strengthened with a strip of metal. A plate of this character, he maintains, forms a thoroughly stable fulcrum.

The forceps recommended by Dr. Bryan are shown in fig. 144.

Mr. Cunningham, in a paper read before the World's Columbian Dental Congress,[1] has applied the method of regulating somewhat extensively, in one instance five teeth having been moved at one sitting. The paper, which records several cases and is fully illustrated, is well worthy of perusal.

In the plan he recommends, cuts are made through the alveolar process on either side of the tooth to be moved. The tooth with

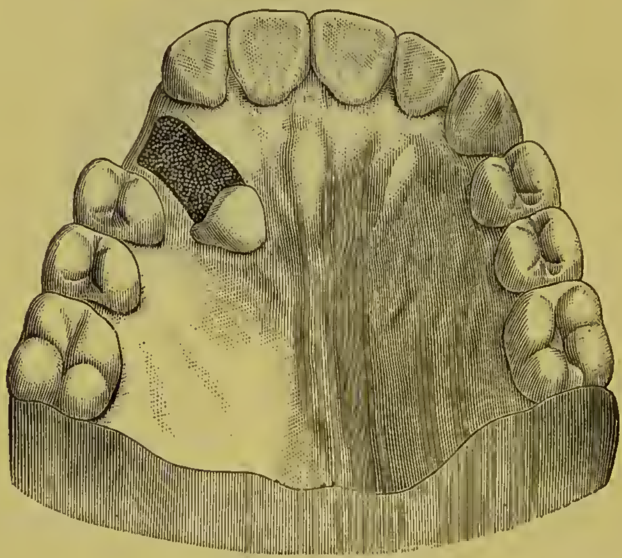

FIG. 145.—Method of treating an instanding maxillary canine.

the anterior part of the socket is then brought forwards with forceps similar to those recommended by Mr. Bryan. Antiseptic precautions should be taken. The tooth is fixed in its new position with a ligature or splint.

Mr. W. H. Dolamore,[2] who has had considerable experience with this method of regulating, attaches great importance to the proper fixation of the tooth after correction and adopts a metal splint fitted over the tooth and fixed with cement. In preference to the circular-bladed saw he uses one somewhat like a Hey's, only thinner.

Dr. Talbot[3] advocates a combination of surgical with mechanical

[1] Vol. i., p. 129.

[2] *Transactions of the Odontological Society of Great Britain*, vol. xxxii., p. 42.

[3] *Dental Cosmos*, vol. xxxviii., p. 909.

treatment. His method consists in removing the osseous tissue in "the line of travel of the tooth to be moved, leaving a small amount of process about the root of the tooth, holding intact the peridental membrane" (figs. 145 to 147). For this purpose he employs coarse-cut burs. He states that he has practised the method for over

FIG. 146.—Method of retracting a mandibular canine.

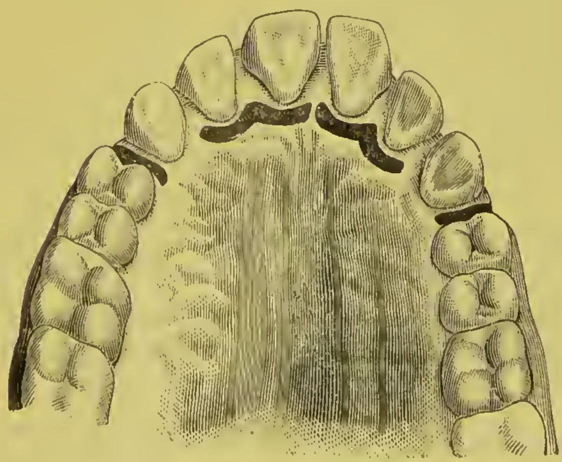

FIG. 147.—Method of treating a case of superior protrusion.

seventeen years, and that although he has had a few cases of infection, such contingencies in his opinion need not be seriously considered, as with proper precautions no bad results will follow.

There is much to be said for and against immediate regulation,

but until its methods have been more fully tested, it will be difficult to express a definite opinion as to its value. The results already obtained certainly justify a more extended trial of the methods advocated.

(E) IRREGULARITIES IN POSITION OF INDIVIDUAL TEETH NOT THE RESULT OF CROWDING.

(1) MAXILLARY INCISORS.

The more common irregularities in position of these teeth are :—

(*a*) Displacement external to the arch.
(*b*) Displacement internal to the arch.
(*c*) Rotation.
(*d*) Separation of the central incisors.
(*e*) Overlapping.
(*f*) Elongation.
(*g*) Displacement upwards.
(*h*) Total displacement, including transposition.

(*a* and *b*) **Displacement external or internal to the arch.**

(i.) *Causes.*—The eruption of an incisor external or internal to the arch may be due to—

(α) Persistence of a deciduous tooth (see p. 65).
(β) The presence of a supernumerary tooth.

In cases where a superior incisor has erupted so that the lower lip passes behind it, the amount of projection will be greatly increased. The habit of sucking the thumb, lip, or even the toe, may lead to protrusion of the incisors. Protrusion of an upper incisor may be due to irregularity of the lower teeth.

(ii.) *Treatment.*—Teeth that erupt internal to the arch may be treated in two ways, either by an upper plate with wires or wedges, or a lower plate with an inclined plane. The above irregularities cannot be treated too early, because the teeth are more easily moved before calcification of the roots is complete.

In teeth which show signs of erupting external to the arch it is generally sufficient to remove the deciduous tooth and leave nature to complete the process of regulation. If, however, the tooth falls outside the lower lip, mechanical measures must be resorted to.

After correction it will be necessary to retain the teeth in position for from three to six months.

(*c*) **Rotation of the incisors.**

(i.) *Causes* :—

(*a*) Persistence of deciduous teeth.

(β) Developmental mal-direction.

(γ) Presence of supernumerary teeth.

(δ) The action of the frænum of the lip (see p. 68).

(ϵ) The pressure of the erupting canine.

Lateral incisors are more commonly found rotated than central incisors. The amount of rotation may vary from an eighth to half a turn. It is well to bear in mind that rotation of the incisors is frequently a sign that the patient will in the future develop a crowded mouth.

(ii.) *Treatment.*—In treatment the first step is to remove, if possible, the cause. The actual rotation of the tooth may be accomplished by either *gradual or immediate torsion.*

(*a*) **Immediate torsion** consists in turning the tooth with forceps, **gradual** in rotating the tooth by mechanical methods. The main points in favour of immediate torsion are the saving of time and the avoidance of a plate. Against the immediate method there are the following disadvantages :—

(1) Liability of the tooth to completely leave the socket during the operation.

(2) The risk of death of the pulp from strangulation of the vessels at the apex.

(3) Fracture of portions of the enamel from pressure of the forceps.

(4) Fracture of the root (in the case of the end being twisted).

As a rule immediate torsion should not be resorted to after the root of the tooth is complete, which usually occurs about the age of ten. Prior to that age the apical foramen is large, and there is less danger of twisting the vessels. Cases are recorded where torsion has been performed at the ages of 12, 14, or even later, and although many of these operations proved successful, some were failures. If the failures amount to only 5 per cent. it is a question whether it would be justifiable to subject patients to even that risk, when by gradual torsion the irregularity can be remedied by a safer, if slower, method.

In cases where the root may be considered fully formed, or

there is any reason to suspect that it may be twisted, a skiagram should be obtained with the object of ascertaining the shape of the root.

In cases of immediate torsion a model should be taken prior to the operation, the tooth being cut off the model and refixed in the position it will occupy after rotation. To the corrected model a thin tin splint should be made to cover the lower third of the tooth to be operated on as well as the approximal teeth. This splint is applied by first drying the teeth and then fixing the splint in position with osteoplastic cement.

The operation of twisting the tooth should be performed with a pair of forceps which fits the tooth accurately. The blades should be covered with some such substance as thin lead foil, lint, or cotton wool. Mr. Dolamore recommends the use of india rubber, the elasticity of rubber exerting a force in an upward direction. The tooth should be grasped firmly and slowly rotated, steady pressure in an upward direction being maintained during the process of turning so as to overcome the tendency of the tooth to leave the socket. It is well to turn the tooth slightly more than is required. Immediately the operation is completed the splint should be applied and retained in place for about a week. An antiseptic mouth wash should be prescribed.

It is obviously essential to obtain sufficient room previous to performing the operation. At times it is difficult to gauge the precise amount of space that will be necessary, and one should always take into account the direction of the root of the tooth to be turned, as the tooth will not necessarily occupy the whole space.

Should the accident of complete removal of the tooth from its socket occur, the tooth must be cleansed in an antiseptic solution and replaced. In such cases the tooth frequently remains alive.[1]

If the tooth after rotation shows signs of pulpitis the gum should be painted with lin. iodi, but if this fails to bring relief, and the symptoms become aggravated, the pulp cavity should be opened and the pulp removed under an anæsthetic. It is well not to delay the removal of the pulp, as timely interference may prevent discolouration of the tooth substance, or, what is more serious, suppuration, which may eventually lead to loss of the tooth.

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[1] An interesting example of this was recorded by Mr. A. S. Underwood in the *Transactions of the Odontological Society*, vol. xviii., p. 98.

A case of immediate torsion is shown in figs. 148 and 149.

(β) **The gradual or mechanical torsion** of a tooth can be carried out in a variety of ways, all of which depend upon the principle of two forces working in opposite directions. A favourite method is to fix to the tooth a band to which are soldered two hooks at the mesial and distal angles. Elastic bands are stretched from the hooks to attachments in the vulcanite plate. Other methods might be enumerated, but they all depend upon employing two forces acting in opposite directions.

FIG. 148.—Before treatment.

FIG. 149.—After treatment. The rotated tooth was held in position for three weeks by a tin splint made as suggested in text.

(*d*) **Separation of the central incisors.**

(i.) *Causes :—*

(*a*) The presence of a supernumerary tooth.

(β) The attachment of the frænum of the lip to the gum posterior to the teeth.

(γ) A combination of (*a*) and (β).

(δ) The result of too much room due to some undiscoverable cause.

Slight rotation often accompanies separation of the central incisors.

(ii.) *Treatment.*—As a general rule it may be said that should the cause be removed before the eruption of the canines, the space between the central incisors will become lessened without mechanical treatment, as the pressure exerted by the canines in erupting will produce the desired effect. Supernumerary teeth should there-

fore be removed directly their presence is noticed. The frænum likewise should be cut. That the frænum acts as a cause of divergent centrals is often overlooked, but that such is the case will be easily seen by an examination of this class of irregularity.

The operation of dividing the frænum is easily performed as follows. The free edge of the frænum is seized with a pair of artery

Fig. 150.—Case 1. Before treatment.

Fig. 151.—Case 1. After treatment.

forceps and drawn forward; a V-shaped piece is then removed from it with a sharp pair of scissors, care being taken to cut the part away where it blends with the gum (a point of great importance). The part running between the teeth should also be removed. A strip of lint moistened with boracic acid lotion should be kept between the cut surfaces until the wound has healed, an antiseptic

mouth wash also being given. Cases treated by excision of the frænum are shown in figs. 150 to 153. No mechanical treatment was adopted. Excision of the frænum, if carried out before the eruption of the canines, will be found to lead to excellent results,

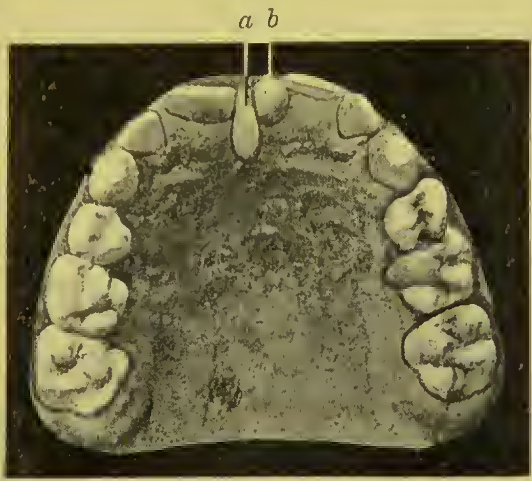

FIG. 152.—Case 2. (semi-diagrammatic).—In this patient the separation of the centrals was due to (*a*) the frænum, and (*b*) a peg-shaped supernumerary tooth.

FIG. 153.—Case 2. After treatment.

but in cases treated subsequent to the eruption of these teeth the benefit is not marked, although the space will tend to close slightly. Should the removal of the cause not prove sufficient to correct the deformity, the teeth can easily be approximated by mechanical methods.

A plate of the form shown in fig. 154 will be found useful. After being brought together it will be necessary to retain the teeth in position by suitable means.

(*e*) **Overlapping of the incisors.**—Slight overlapping of the central or lateral incisors, when not the result of crowding, is often hereditary. The amount of deformity is generally slight and is best left alone.

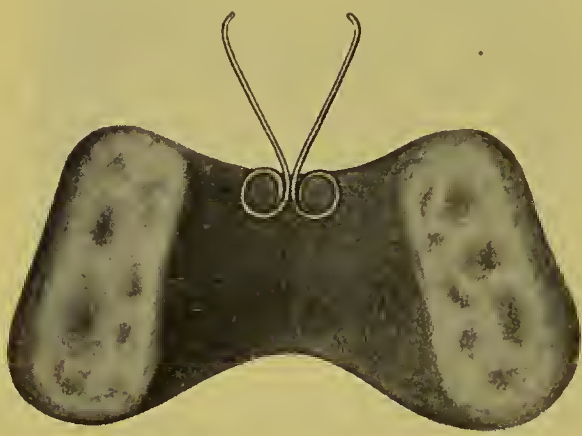

FIG. 154.

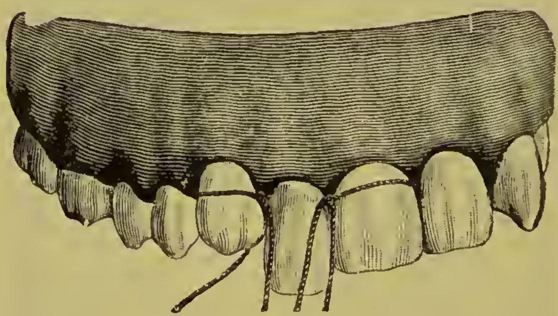

FIG. 155.

(*f*) **Elongation.**

(i.) *Cause.*—**Elongation** of an incisor is usually the result of an accident.

(ii.) *Treatment.*—In cases where the elongation is but slight, the tooth may be cut down by means of carborundum wheels, care being taken to carefully polish the cut surface. In more severe cases an endeavour may be made (if desirable from an æsthetic point of view) to force the tooth into the socket.

A simple method of reducing an extruded tooth is mentioned by Dr. C. L. Goddard:[1] "Silk ligatures are tied around the necks of adjacent teeth (fig. 155) with the knots between each and the offending tooth. Extend one end of each ligature lingually and one labially. Tie the lingual ends together behind the long tooth and in the same knot tie a slender rubber band (figs. 156 and 157). Tie

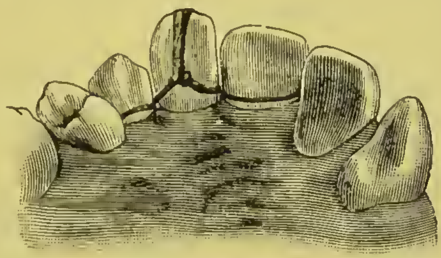

FIG. 156.[1]—Palatal view.

the labial ends together in front of the long tooth. Next stretch the rubber band from the lingual surface of the neck over the cutting edge, and tie it to the knot on the labial surface. The tooth is thus hung in a sling which will force it up into place."

Another method is shown in fig. 158.

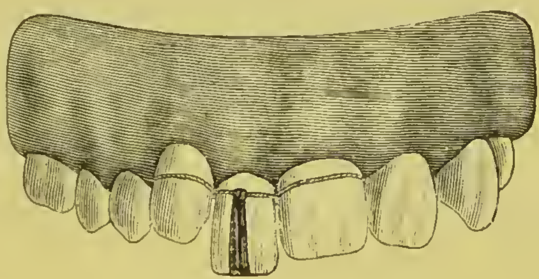

FIG. 157.[2]—Labial view.

The teeth approximal to the one to be regulated are banded, and wires are soldered to connect both the labial surfaces and the lingual surfaces together. The wires can be made to rest in tubes soldered to the bands. Upward pressure is exerted by a rubber band or twisted ligature stretched from the labial to the lingual bar over the cutting edge of the tooth.

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[1] "Text-book of Operative Dentistry" (Kirk).
[2] *Ibid.*

(*g*) **Displacement upwards of an incisor.**

(i.) *Causes.*—This is generally the result of injury, but it may be the result of an error in development.

(ii.) *Treatment.*—If the correction of such a deformity is considered advisable it may be carried out :—

(α) By reducing the length of the approximal teeth.

(β) By forcibly bringing the tooth into place with forceps.

(γ) By mechanical appliances.

(α) **The first form of treatment** may be adopted when the displacement is but slight, and it is better applied to the treatment of centrals than laterals. With the former, a symmetrical appearance can be obtained by grinding down the cutting edge or rounding off

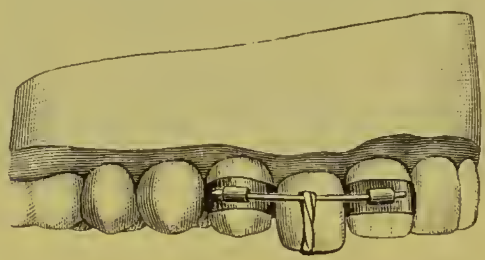

FIG. 158.[1]

the angles of the fellow tooth. With the lateral incisor reduction of the length of the approximal teeth will naturally give an asymmetrical appearance to the mouth. This may of course be overcome by treating the lateral, central and canine on the other side of the mouth in a similar manner—a plan seldom advisable.

(β) **The second method of treatment** may be adopted in cases of forcible displacement upwards which are seen at an early date after the accident.

(γ) **Treatment by mechanical appliances** may be accomplished by the plan shown in fig. 159, the suggestion of Dr. C. L. Goddard. Caps connected by a wire are attached to the teeth approximal to the one to be regulated. To the latter tooth a band is adjusted, hooks being soldered to the labial and lingual surfaces. Traction force is obtained by an elastic band arranged as shown in the illustration.

(*h*) **Total displacement of the incisors.**—Incisors may be transposed, that is, occupy a position in the arch which should be held

[1] From "Text-book of Operative Dentistry" (Kirk).

by another tooth. For instance, the central and lateral may exchange positions, or the lateral may occupy the position of the canine. Cases of transposition do not call for treatment. The incisors may be completely displaced, as shown in fig. 160. It is needless to say that the only treatment for such abnormalities is extraction. Occasionally the incisors erupt high up in the alveolar arch with the cutting edges directed forward. Such teeth are

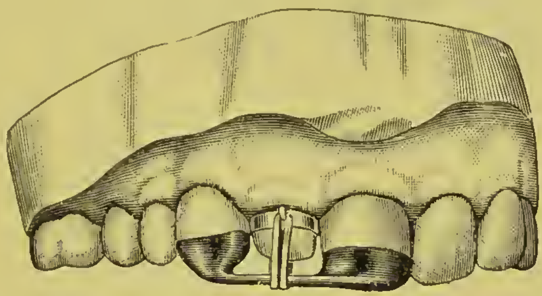

FIG. 159.[1]

FIG. 160.

usually "dilacerated," and endeavours to train them into place would prove futile. Extraction is the only remedy. In cases of cleft palate complicated by hare-lip the incisors adjacent to the fissure are often misplaced. As a rule it is wise not to attempt their regulation, the roots of such teeth being usually curved and twisted. If the condition produces great disfigurement the teeth can be removed and a denture inserted.

[1] From "Text-book of Operative Dentistry" (Kirk).

(2) MANDIBULAR INCISORS.

The mandibular incisors may erupt internal or external to the arch—conditions usually produced by persistence of deciduous teeth. The obstructing tooth should be removed and the case left alone, the tongue on the one hand and the lips on the other being usually sufficient to bring the tooth into line. In a few cases the lower tooth may be outside the upper incisors; under such conditions the lower tooth must be retracted or the upper pushed out. Total displacement of the lower incisors is very rare.

(3) MAXILLARY CANINES.

The canine may be misplaced external or internal to the arch, may be rotated, or totally displaced. Abnormalities in position of maxillary canines due to causes other than crowding are comparatively rare. For the methods of correcting the mal-position of canines see p. 129.

Partial eruption of the canine is occasionally met with. An attempt to force the tooth to erupt may be made. An appliance

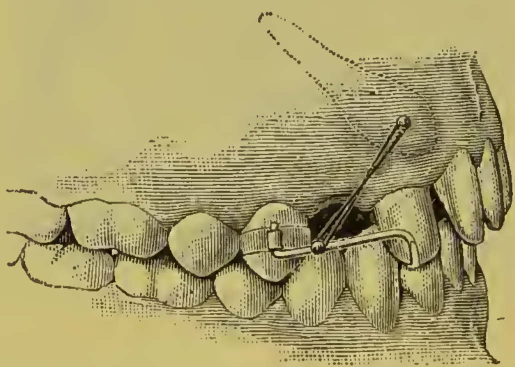

FIG. 161.[1]

for this purpose is figured in Essig.[1] A band is cemented to the first premolar. To this band a tube is soldered. Into this tube a piece of wire is fixed which extends across the space and under the cutting edge of the lateral incisor. A stud is fixed into the canine tooth and traction applied by means of elastic (fig. 161).

[1] "Text-book of Prosthetic Dentistry" (Essig).

Success is by no means certain, and in one case under treatment the tooth resisted every effort made to regulate it. In all cases where the permanent canines erupt late and do not show signs of coming into correct position a skiagram should be obtained, and if the direction is seen to be abnormal or the root shows signs of being twisted, the tooth should be removed and the deciduous canine retained.

Complete displacement. — The maxillary canine is completely displaced more frequently than any other tooth. It may erupt adjacent to the central incisor and in the position of the first or even the second premolar. It may erupt into the nose, be placed horizontally in the palate, &c.

(4) MANDIBULAR CANINES.

Irregularities of the mandibular canines, from causes other than crowding, are rare. In the case shown in fig. 162 the permanent canine has erupted internal to the arch. The deciduous canine is

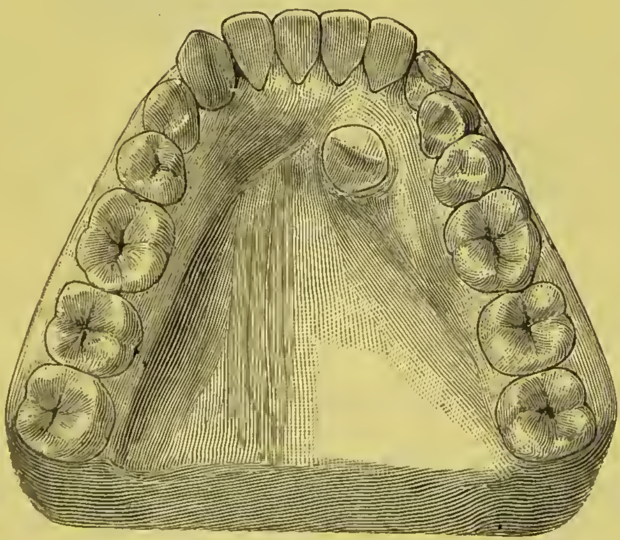

Fig. 162.

in position. The patient was thirty years of age, and the permanent tooth appeared two years previous to her seeking advice. The treatment consisted in removal of the misplaced tooth.

An interesting example of a misplaced lower canine was recorded by Mr. C. Truman.[1] The tooth appeared under the chin, apparently having been directed in its course by the presence of a sinus. After its removal a premolar made its appearance in the same position (fig. 163).

FIG. 163.[2]

(5) PREMOLARS.

Abnormalities in position of the maxillary and mandibular premolars from causes other than crowding are uncommon. A case of transposition of a premolar is shown in fig. 164. Cases of premolars which have remained embedded in the jaw have been recorded.

[1] *The Transactions of the Odontological Society*, vol. xxiii., new series, p. 34.
[2] From *St. Thomas's Hospital Reports*, 1893.

(6) MOLARS.

Maxillary.—Of the maxillary molars, the third is occasionally displaced. This tooth may erupt obliquely or horizontally towards the cheek, or it may be directed posteriorly towards the hamular process. Complete displacement of this tooth may occur, for example, it may be caught by the roots of the second molar, as seen in fig. 50. The museum of the Odontological Society contains a model showing the third molar erupted in the median line of the palate.

Mandibular.—The third molar is frequently displaced. It may be tilted so that the occluding surface looks forwards, or it may

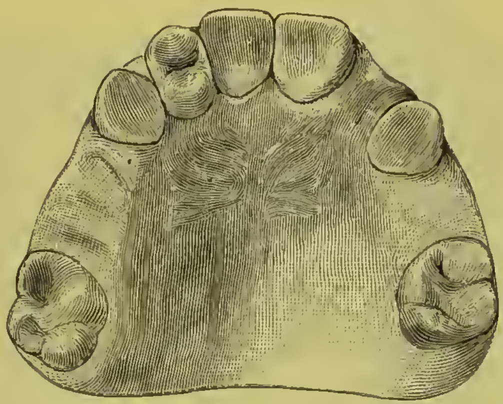

Fig. 164.

assume a horizontal position so that its occluding surface impinges on the posterior aspect of the root of the second molar. This irregularity is often symmetrical. Mr. Tomes, in his "Dental Surgery," figures a case where the third molar erupted at the angle of the jaw. In a specimen given by the late Sir Edwin Saunders to the Odontological Society the third molars are situated in the ascending rami, the occluding surfaces being nearly level with the sigmoid notches.

(F) IRREGULARITIES IN POSITION OF TEETH, THE RESULT OF CROWDING.

(1) CAUSES.

If the skull of a child about six years of age be examined the permanent teeth will be found as follows (fig. 165).

In the maxilla the lateral incisors lie in a plane slightly posterior to the centrals, and are directed more vertically. The pre-

molars are embraced by the roots of the deciduous molars and their crowns are directed inwards, the second more than the first. The first premolar is normally situated close to the lateral incisor. The canine lies above and external to the arch of the incisors and premolars and is directed slightly inwards. The first permanent molar will be in the process of erupting, and the occluding surface will be directed outwards to a slight extent. The second permanent molar is situated high up in the tuberosity of the bone, with its occluding surface directed downwards, outwards and well backwards.

FIG. 165.

In the mandible the lateral incisors lie in a plane posterior to the centrals, and the canines are placed near the lower border of the bone and lie in a plane anterior to the lateral incisors with a slight tilt towards the median line. The premolars are embraced by the roots of the deciduous molars and their crowns are directed inwards. The first permanent molars are directed upwards and forwards, the second being under the base of the coronoid process with the occluding surface directed upwards, forwards and slightly inwards.

The permanent incisors, canines and premolars, when erupted, are confined to the space previously occupied by the deciduous teeth.

The permanent incisors replace the deciduous incisors. Space for the greater breadth of their crowns is obtained by their assuming a more sloping direction and thus occupying the arc of a larger circle. The permanent canine is larger than the deciduous canine, but the premolars are smaller than the deciduous molars, the increase in size in the former being counterbalanced by the decrease in the latter. Room for the permanent molars is gained by the backward growth of the jaw. In this way a regular arch is obtained.

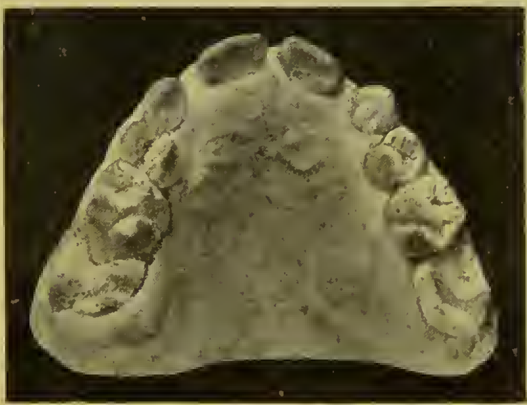

FIG. 166.

In the normal condition a distinct relationship exists between the size of the teeth and the size of the jaws. Within modern times the size of the jaws has diminished to a greater degree than the size of the teeth, with the necessary result that the teeth, when erupted, assume a crowded position in the arch.

Subsequent to birth a certain amount of arrest in the growth of the jaw may result from various causes, but if we accept the present theory of development this would only tend to lessen the space available for the molars. The molars not having sufficient room would force themselves forward and so encroach upon the space to be occupied by the second premolar. This apparently occurred in the case shown in fig. 166. The molars were abnormally placed, and in their eruption caused so much absorption of the second deciduous molars that the latter were lost at an early period. The encroachment of the first permanent molars on the space previously

occupied by the second deciduous molars had the effect of forcing forward the premolars so that the canine, through lack of space, erupted external to the arch (fig. 167). In a somewhat similar case which has recently come under observation, the permanent

Fig. 167.

molars had caused so much absorption of the second deciduous molars that the latter had to be removed (figs. 168 and 169). In both these cases it is difficult to say whether the direction of the permanent molars was the result of crowding due to inherent

Fig. 168.

smallness of the maxilla, or whether it was due to some arrest in the growth of the bone subsequent to birth. This condition is, however, interesting, and one which is not generally recognised. The early removal of the second deciduous molar as a cause of

crowding was alluded to on page 64. A crowded condition of the teeth may also arise from the presence of supernumerary teeth.

The positions which the teeth assume in a crowded mouth depend mainly upon—

(*a*) The position of the teeth in their crypts.

(*b*) The order of eruption.

(*c*) The density of the alveolar process.

(*d*) The influence of the tongue and lips.

(*e*) The occlusion of the teeth.

(*a*) It has already been shown that even under normal conditions the permanent teeth are arranged in their crypts in an irregular manner, and it necessarily follows that the irregularity of their

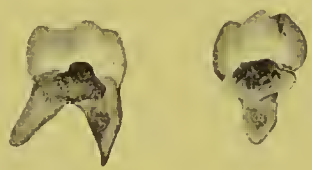

FIG. 169.

positions will become more marked as the space available for their development diminishes ; the lateral incisors will perhaps be placed more inwards and the canines more outwards. The direction which a tooth takes in erupting is probably in the same line as the long axis of the tooth in the crypt, and herein, perhaps, lies the explanation of the frequent eruption of the lateral incisors and the premolars internal, and the canines external, to the arch in cases of crowded mouths.

(*b*) The order of eruption is an important factor in determining the character of an irregularity and this is well shown in cases of crowding which result from early loss of the second deciduous molar. When the teeth appear in normal order the canine erupts subsequent to the second premolar, hence if there is insufficient room in the arch the canine will be the principal disturbing factor. If there is a moderate interval between the lateral incisor and the first premolar, the canine will force its way into the arch causing disturbance in the position of the incisors, but if the interval is slight, the result will be the extrusion of the canine from the arch and, in all probability, external to it. The pressure of the canine will also in many cases force the incisors inwards and outwards, producing a V-type.

Should the canine erupt previous to the second premolar the disturbance in the position of the anterior teeth will be less noticeable. The incisors, canine and first premolar will erupt in a fairly regular manner, the premolar being forced towards the first molar. If the space is but slight the second premolar will erupt internal to the arch and cause but little disturbance. On the other hand, if there is a nearly normal interval the second premolar in erupting will, in all probability, cause displacement inwards of the first premolar and so produce a type of saddle-shaped arch.

(*c*) The extent of the disturbance in position of the teeth already in place caused by those erupting depends mainly upon the density of the alveolus. In strong, robust subjects the teeth already in place suffer but little disturbance, and the erupting tooth is, as a rule, the only one irregularly placed, but with patients of feeble constitution, where the bone is soft and yielding, the effect on the teeth already in position is marked.

(*d*) and (*e*) The tongue, the lips, and the occlusion of the teeth naturally determine to a great extent the position the teeth assume.

(2) TREATMENT.

(*a*) **General points.**—In deciding upon the method to pursue in the treatment of a crowded mouth, there are at least three points which should be carefully kept in mind.

(i.) **The great prevalence of dental caries.**—Caries of the teeth is so prevalent and so much on the increase that it is most important that in the treatment of crowded mouths methods should, if possible, be adopted which will help to reduce the tendency to caries. In this connection it should be mentioned that isolation of the teeth is of the greatest advantage, whilst mechanical appliances should be avoided whenever possible, as they are liable to cause caries either by injury to the enamel or by the lodgment of particles of food against the surfaces of the teeth.

(ii.) **The increasing liability to lose the teeth by chronic periodontitis.**—Although often lost sight of, the liability for teeth which have been regulated by mechanical methods to be attacked by periodontitis, is within the knowledge of all practitioners, and affords another strong argument against the use of mechanical appliances.

(iii.) **The size of the maxilla and mandible.**—In the majority of cases which come under treatment either the maxilla or the mandible is too small to accommodate the normal number of teeth, and this fact, which is frequently overlooked, should considerably influence one in selecting a line of treatment.

(*b*) **The methods available for the treatment of crowded mouths** are:—(i.) Expansion of the arch; (ii.) extraction; (iii.) a combination of expansion with extraction.

(i.) **Expansion of the arch** as a remedy for crowding was first suggested by Dr. Coffin, and consists in moving all the teeth, or a large number of them, in an outward direction. On a previous

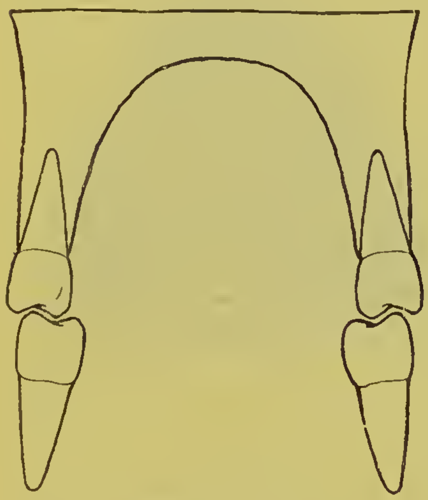

FIG. 170.

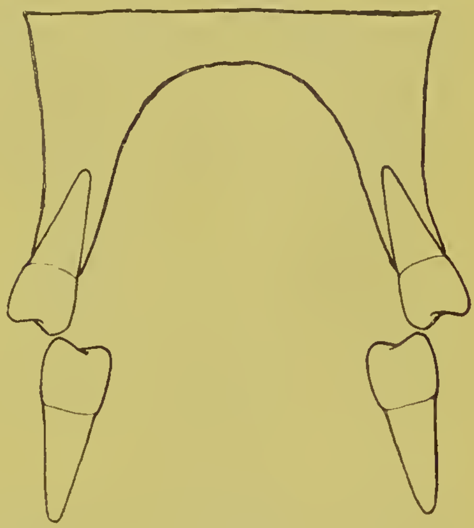

FIG. 171.

page the question of the movement of teeth, when treated mechanically, was discussed, and it was shown that with the majority of appliances the tooth for all practical purposes may be considered to swing on its apex. In expansion, then, the crowns are made to occupy a greater arch, but the apical portions remain in practically the same crowded condition. There is, therefore, no true relief to the crowding and hence a relapse frequently takes place. Expansion of the arch sometimes results in a considerable disarrangement of the occlusion of the teeth, while the extreme slope at times given to the anterior teeth is most unsightly. The method has, however, the advantage of bringing the teeth into a regular arch without the loss of any of their number, and this is a great

8

attraction to many. The normal direction of a tooth is slightly outwards, as shown in the diagram (fig. 170). The effect of expansion under such conditions is to drive the tooth in a still more outward direction and completely disturb the occlusion, as shown in fig. 171. The most suitable cases for expansion are those where the teeth slope inwards (fig. 172). Expansion then brings the teeth into a normal direction, and occasionally improves the occlusion.

Expansion usually entails a long period of mechanical treatment, and where there is a tendency to approximal decay it is

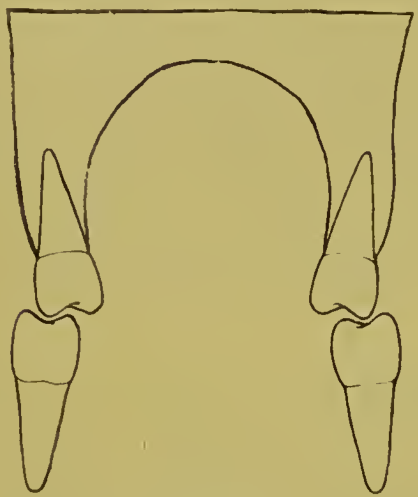

Fig. 172.

Fig. 173.

certainly not a desirable operation. It is suitable for cases where the crowding is slight, the teeth of good structure, and where the direction of the teeth will be made normal.

The most suitable appliance for expanding the arch is that suggested by Dr. Coffin (fig. 173). The plate should be inserted without being cut down the centre, and should be worn for about forty-eight hours. This will allow it to adjust itself thoroughly to the mouth, and when subsequently cut down the centre it will work more satisfactorily.

(ii.) **Extraction** for the relief of crowded mouths possesses many advantages:—

(α) Room is gained not only for the crowns but also for the roots of the teeth.

(β) Mechanical treatment is lessened and in many cases dispensed with.

(γ) Isolation of the teeth is often obtained, which is a point of therapeutic importance in the treatment of caries.

(δ) The bite is but little disarranged, provided the extraction is judiciously carried out.

(ϵ) The teeth invariably assume better directions.

In the large majority of cases extraction is far preferable, and is certainly more rational than expansion of the arch.

When employing extraction it is **rarely needful to remove a central incisor.** Occasionally the removal of the **lateral incisors** or **canines** is necessary. Generally a tooth posterior to the canine can be removed, and a choice has to be made between the first and second premolars and the first permanent molar.

The removal of the **first premolar** has the advantage of relieving the crowding of the anterior teeth more easily than the removal of either the second premolar or first permanent molar. Its removal causes but little disturbance of the occlusion of the teeth. If, however, the amount of room required is slight there is a risk of creating too great a space between the canine and the second premolar.

Extraction of the **second premolar** gives less room than removal of the first premolar and probably more room than removal of the first permanent molar. The occlusion of the teeth is but little disturbed, and any space that may result would be between the first premolar and first permanent molar, and would be less unsightly than a space between the canine and second premolar. Removal of the second premolar has the advantage of freeing the anterior surface of the molar, which will lessen the tendency to caries and allow any caries which may exist to be more easily treated. The premolars are less prone to caries than the first permanent molars, but it is doubtful if the difference in liability to caries is as marked as statistics would appear to indicate. Approximal decay is more difficult to cope with in the premolars than in the first molar. Experience teaches that a first permanent molar can be more easily saved than the premolars.

Removal of the **first permanent molar** gives less room than the removal of the first premolar or, probably, the second premolar. The treatment necessary is also more prolonged and the occlusion of the teeth is frequently much disorganised, the second lower permanent molars tilting and the premolars, both upper and lower, rotating. As an organ of mastication the first permanent molar is

most important. It possesses the largest area of crown surface, and is situated in that part of the arch where the muscles of mastication work to greatest advantage. Unfortunately it is more liable to caries than any other tooth, but if patients are seen at regular intervals the caries can be treated in the early stages and the tooth easily and permanently saved.

Its importance as an organ of mastication is so great, and the disturbance to the articulation caused by its removal so marked, that only when the tooth is unsaveable should it be removed for the relief of crowding. Under all other circumstances the choice should be made between the first and second premolars; if both teeth are free from caries, the first should be removed if the crowding is marked; if but little space is required the choice should fall on the second premolar.

(iii.) **Combination of extraction with expansion** is occasionally useful in cases where the amount of crowding cannot be wholly overcome by expansion, and yet expansion is to some extent desirable from an æsthetic point of view.

(*c*) **Early Treatment.**—In mouths where crowding is inevitable, treatment should be commenced at an early age. For simplicity of description this question will be considered under two headings :—(i.) Cases where the first permanent molars are unsaveable: (ii.) Cases where the first permanent molars are saveable.

(i.) Cases where the First Permanent Molars are Unsaveable.

In these cases good results accrue from a line of treatment somewhat similar to the following :—The first permanent molars are filled or treated in the manner best calculated to retain them until the second permanent molars have erupted. The crowding of the upper and lower incisors is then relieved by the removal of the four deciduous canines. If the teeth erupt in the normal way, the first and second premolars will come into good position, and we shall then have the following condition : the four incisors and the four premolars will be in a regular arch, with a greater or less space between the lateral incisors and the first premolars, so that the canines erupt just external to the arch ; in other words, we shall have to deal with a fairly simple irregularity, namely, the canines high in the arch. To make room for the canines, the first permanent molars should be removed directly the second permanent

molars are fairly through the gums. A plate to hold back the second molars should then be inserted. This plate (fig. 174) is made to cover the palate in such a way that it comes in contact with the palatal surfaces of the incisor teeth, while to the back of it are fixed half-round gold wires which pass around the anterior and buccal surfaces of the second molars, the plate being quite free of the premolars. This form of plate retains the second molars in position, and prevents them from moving forward, while at the same time it allows the premolars to fall back, partly by the action of the bite and partly by the pressure of the canine tooth, so that many cases require no further mechanical treatment—a point of no

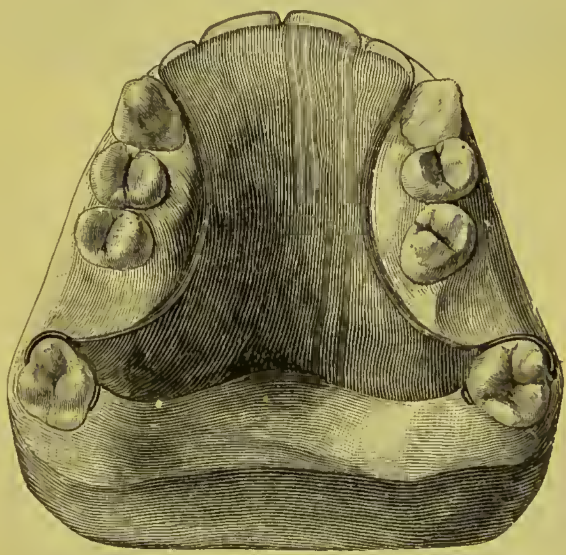

FIG. 174.

small importance. Obviously this line of treatment will not apply in all cases. In some patients the lower front teeth are so crowded at an early age that extraction of at least one of them becomes necessary. A good example of this is seen in fig. 175. Here the first permanent molars are quite unsaveable, and the crowding of the lower incisors is excessive. This condition is due to pressure from the canines, and removal of the first permanent molars will not sufficiently relieve the pressure to allow the laterals to assume anything approaching a normal direction. If left untreated, the lower canines will in all probability erupt in a plane anterior to the laterals. Removal of the right central incisor, however, will

relieve the crowding and allow the remaining teeth to assume good direction. The result of treatment is seen in fig. 176.

Another example, which could hardly be carried out on the general principles just indicated, is to be found in cases where, at an early age, it is clear that the maxillary permanent canine will erupt over the position of the lateral. Under such circumstances

FIG. 175.

the lateral is forced much internal to the bite, or is twisted and turned in some very abnormal position. The lateral incisors must be extracted, and this should be done before the canines erupt. The first permanent molars should be removed before the eruption of the second permanent molars, in order that the latter may move well

FIG. 176.

forward, and so fill up the gap caused by the extraction of the first permanent molars. This will prevent undue spacing between the anterior teeth, which would be unsightly.

(ii.) **Cases where the First Permanent Molars are Saveable.**

(*a*) **Early removal of the first premolar.**—Attention here should, in the first instance, be directed to the first permanent molars, and these teeth should be filled in as permanent a way as possible. The

probable position of the permanent canine should next be determined. If the incisors are in a fairly regular line, or if the lateral has its mesial angle tilted forward, we may assume that the canine will erupt posterior to the lateral. If, on the other hand, the distal edge of the lateral is projected forward and the apex of that tooth is directed towards the median line, we may conclude that the canine will, in all probability, erupt over the situation of the lateral, and the same may be assumed if the lateral is placed much internal to the bite, and the deciduous canine lies close to the central.

In instances where the canine shows signs of erupting posterior to the lateral, room should be obtained by the removal of the first premolar as soon as possible. In most cases it is advisable to remove this tooth even if unerupted.

The latter operation consists in removing the deciduous first molar, and then the premolar. This was first suggested by Mr. Tomes for the treatment of that irregularity of the lateral incisor where the mesial angle is tilted forward and directed towards the median line, and, as is well known, this irregularity is extremely difficult to correct if left until the permanent canine has erupted.

If a skull exhibiting this condition be examined, it will be noticed that the irregularity of the lateral is produced by the permanent canine pressing on the end of the root of the lateral. To relieve the pressure there is but one method available, namely, to remove the premolar, and so allow the canine to fall back. It may be argued that extraction of the deciduous canine would be sufficient to remedy the condition of the lateral, but if the dried specimen be carefully studied, it will be noticed that the removal of the deciduous canine will not have the desired effect of giving room for the permanent canine.

In performing this operation, an anæsthetic should always be given, as the removal of the premolar is frequently difficult. If we confine our attention to one side of the mouth at a time, nitrous oxide administered in the usual way is quite sufficient; but if it is desirable to remove both premolars at one sitting, then ether must be used or a prolonged nitrous oxide anæsthesia obtained by one of the methods recently introduced. The most suitable instrument for the removal of the teeth is a pair of Read's upper root forceps with rather long blades. The deciduous molar is first removed, and in attempting the extraction of the premolar the blades should be opened fairly wide; this is worthy of remembrance, because there

is a decided tendency not to keep them open sufficiently. The external blade should be kept well outwards. It is well to advise the use of an antiseptic mouth-wash after removal, and if the extraction has been difficult, the wound should be syringed several times a day.

FIG. 177. Case 1.—Upper, before treatment.

FIG. 178. Case 1.—Upper, after treatment.

FIG. 179. Case 1.—Lower, before treatment.

FIG. 180. Case 1.—Lower, after treatment.

Crowded mouths treated in this manner give excellent results. The canine moves into the space previously occupied by the premolar. Pressure on the front teeth is relieved, a good arch is obtained, and what is most important, the teeth will be in excellent direction. In addition, mechanical treatment is avoided, and the

FIG. 181. Case 2.—Before treatment. In this case the lateral incisors had to be pushed forward over the lower teeth.

FIG. 182. Case 2.—After treatment.

FIG. 183. Case 2.—Side view, showing occlusion of premolars and molars after treatment.

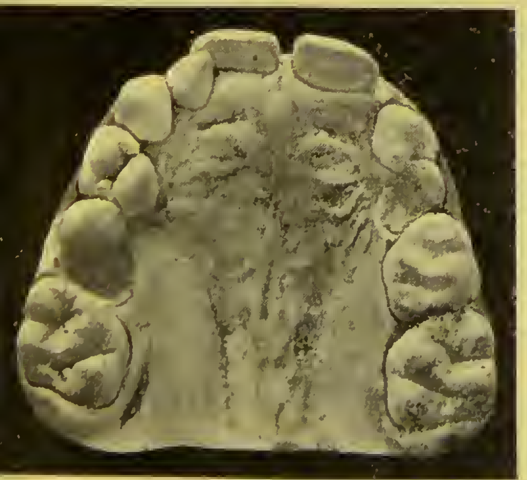

FIG. 184. Case 3.—Before treatment.

FIG. 185. Case 3.—After treatment.

articulation of the molars and premolars remains good. (Figs. 177 to 186 are examples of this form of treatment.)

The advantages of the early extraction of the premolars, where a crowded mouth is in the future inevitable, are :—

(1) Pressure on the front teeth being relieved, any irregular position they may have assumed is rectified easily by natural methods.

(2) The canines and premolars come down in a good direction and form a regular arch.

FIG. 186. Case 3.—Side view, showing occlusion of premolars and molars.

Experience teaches that the actual time for the removal of the premolars must depend largely upon the amount of contraction or irregularity present.

In very crowded mouths, and probably in cases of superior protrusion, the earlier that extraction is resorted to the better, while, with a slight amount of crowding, the removal of the tooth may be delayed. But no hard and fast rule can be laid down, and each case must be decided upon its individual merits.

(β) **Early removal of the lateral incisors.**—In cases where the canines show signs of erupting over the situation of the laterals, the removal of the premolars does but little good, and such cases are treated much more satisfactorily by removing the lateral incisors. This should be done before the canines erupt. Cases treated in this way are shown in figs. 187 to 190.

(*d*) **Treatment of cases coming under observation after the majority of the teeth have erupted.**

Fig. 187.—Before treatment.

Fig. 188. Case shown in fig. 187.—After treatment.

Fig. 189.—Before treatment.

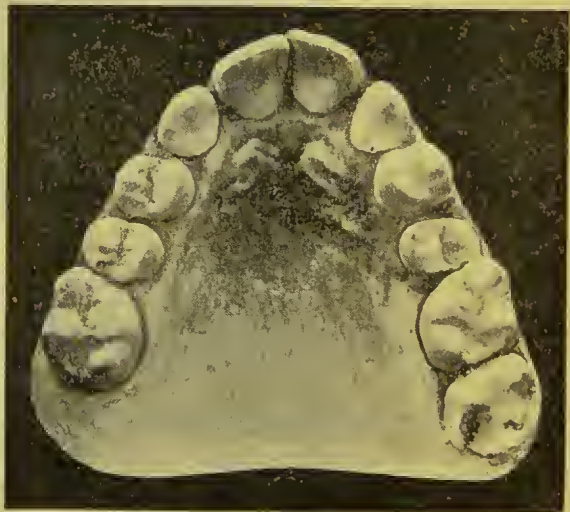

Fig. 190.—Case showing fig. 189.—After treatment.

(i.) **Cases of crowding complicated by disease of a central incisor.**—In considering the treatment of such cases our decision must depend upon—

(α) The prospects of permanently retaining the affected tooth.
(β) The degree of crowding.
(γ) The sex of the patient.
(δ) The age of the patient.

If the pulp of the tooth died subsequent to the completion of the root, and no periodontal mischief supervenes or if present is

only slight, there is a reasonable prospect of permanently saving the root and affixing a crown. Under these conditions the central should be saved, and the crowding treated by the removal of a posterior tooth.

If, however, it seems probable that the pulp died prior to the completion of the root, and the chronic periodontal trouble is extensive, the chances of permanently retaining the tooth will be remote, and in most cases it would be advisable to remove it.

Fig. 191.

Fig. 192.

The loss of a central incisor in the case of a boy can be usually hidden subsequently by a moustache, but with a girl the disfigurement is serious and every effort should be made to retain the tooth until it is deemed advisable to insert an artificial denture, the obvious disadvantages of a denture being in this case more than outweighed by the gain in personal appearance. But even with a girl extraction would be the better course if the crowding is excessive and the tooth not permanently saveable.

In the case shown in fig. 191 the left central incisor projected and was attacked by a chronic suppurative periodontitis, the patient having injured the tooth by a fall at the age of eight. An unsuccessful attempt having been made to treat the tooth, it was

FIG 193

FIG. 194.

extracted. The first permanent molars, which were unsaveable, were also removed. Fig. 192 shows the case after the eruption of the permanent canines.

(ii.) **Crowding resulting in the protrusion of a central incisor.**—

An example of this irregularity is shown in fig. 193. The patient was 21 years of age. The arch was expanded by means of a plate similar to fig. 173. A half-round gold wire was fixed to the outer side and made to impinge upon the projecting incisor, the plate being cut away upon the palatal surface to allow the tooth to move inwards. The result of the treatment is shown in fig. 194.

The model shown in fig. 195 illustrates a similar irregularity. In this case the tooth was removed, as the patient, a man aged 24, was shortly going abroad where he would be unable to obtain treatment.

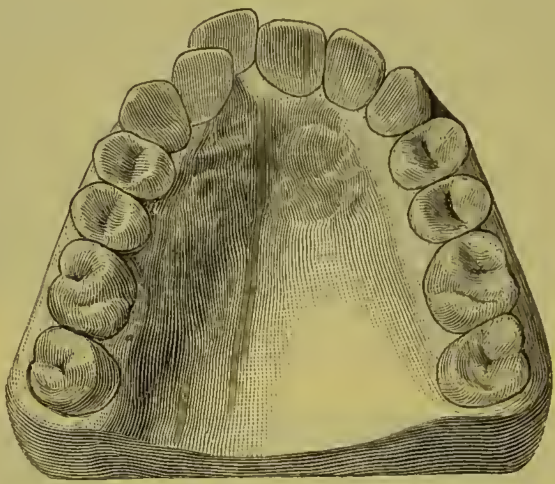

FIG. 195.

(iii.) **Crowding resulting in the exclusion of laterals from the arch.**—The advisability of sacrificing a lateral incisor in the treatment of crowding is constantly disputed, some practitioners even going so far as to maintain that under no circumstances is such a course desirable. The principal argument urged against the removal of this tooth is that the canine erupts next to the central and produces an unsightly appearance. It is true that a lateral in correct direction has a better appearance than a canine next to the central, but in cases where the extraction of a lateral is a matter for consideration, the problem to be solved may be put in this way. Is it better to have a canine in correct alignment next to the central and the premolar in apposition to the canine, or a lateral in a mal-direction with, possibly, its cutting edge tilted forward and the canine sloping towards the median line, and in all probability short? Take as an example the case shown in fig. 196. The laterals are

displaced inwards to a considerable extent and are in a vertical direction, the canines being but slightly external to the arch. An examination of the roots of the teeth shows the canines to be sloping towards the median line, while the roots of the first premolars take the same direction. Extraction of the laterals will effect a remedy without mechanical treatment; the canines will come down in good direction, the centrals will fall back and assume a more correct position, while the premolars will move forward also into a vertical position.

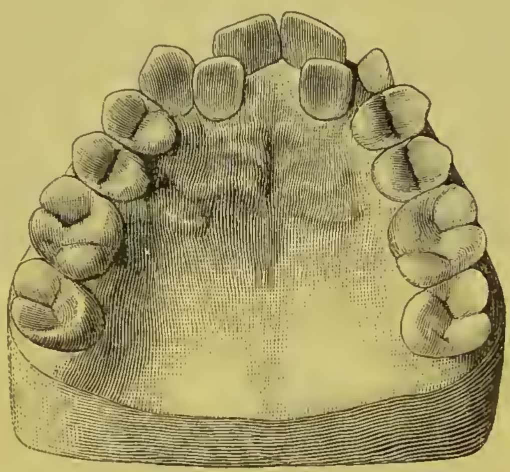

FIG. 196.

If an attempt were made to treat the case by extraction of the first premolar the result obtained would, in all probability, be far from satisfactory. Even with a fairly good result, and with the teeth brought approximately into a normal curve, the difference in the slope of the teeth will produce anything but a pleasing appearance. The central will be forced more outward, the lateral will have its cutting edge directed forward, that is to say, the neck will be in a plane well posterior to the central, the cutting edge of the canine will be above the level of the lateral and the slope will be considerable.

Further, this operation will entail prolonged mechanical treatment with all its attendant troubles. A row of teeth in correct alignment with the canine next to the central is more sightly than a row of teeth in bad alignment with the lateral next to the central; and, moreover, it must not be forgotten that the public do not view the teeth with the professional eye of the practitioner. Diagrams illustrating these points are shown in figs. 197 to 199.

A case calling for the removal of the laterals is shown in fig. 200.

The cases, however, which test the judgment most are those where the root of the canine is directed only slightly towards the median line and there is a possibility of the tooth coming into good direction if the premolar is removed. Under these conditions the removal of the premolar would be the wiser course, especially if the patient is a girl.

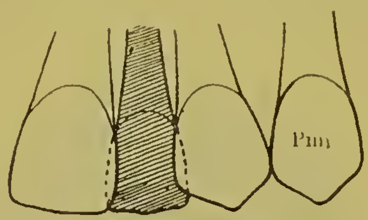

FIG. 197.—Case before treatment, showing positions of incisors and canine.

FIG. 198.—Result of treatment after removing the first premolar.

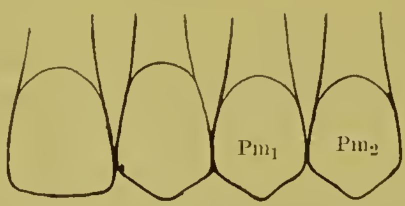

FIG. 199.—Result of treatment after removing the lateral incisor.

Cases are sometimes met with where the laterals are misplaced to such an extent that their extraction is imperative and the first permanent molars are also quite unsaveable. Under such conditions the molars must be removed, and this should be effected if possible before the second permanent molars erupt. The latter will then come forward and in a great measure prevent a backward movement of the premolars, which would probably leave unsightly spaces between the front teeth.

(iv.) **Cases of crowding in which the canine is displaced external or internal to the arch.**—The displacement of a canine external to the arch is the commonest result of a crowded condition of the teeth. A typical example is shown in fig. 201.

Fig. 200.

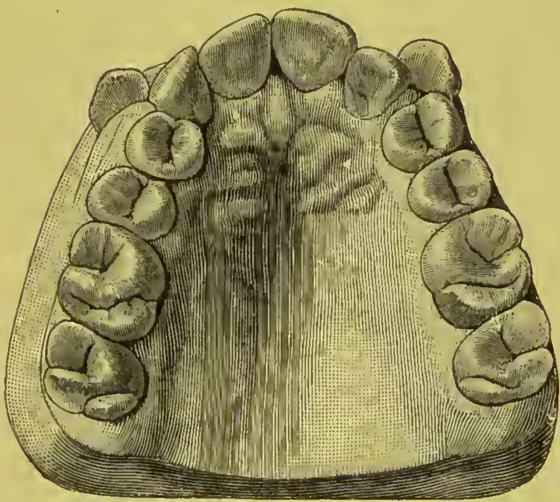

Fig. 201.

In considering this irregularity, it should be remembered that the canine is the most important tooth in the dental arch, forming a kind of key stone, and in a great measure giving character to the face. When extracted, it leaves a depression near the ala of the nose, and robs the face of much expression. It is the longest, and probably the strongest and best developed tooth in the whole arch; for these reasons endeavours should be made to retain it.

The treatment usually resolves itself into the question of whether the lateral, a premolar, or the molar should be removed, or as a last resource the canine. In deciding upon treatment in such cases the position of the root of the canine is of importance.

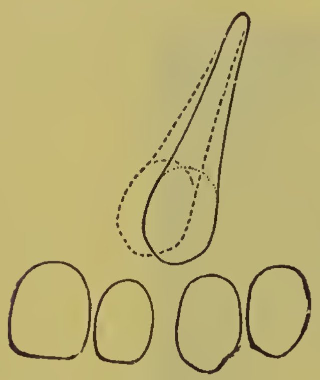

FIG. 202.—Showing the root of the canine lying over the premolar. The dotted lines represent the direction the canine will take if the lateral is extracted.

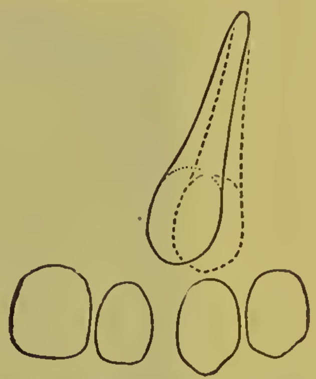

FIG. 203.—Showing the root of the canine lying over the premolar. The dotted lines represent the direction the canine will take if the premolar is extracted.

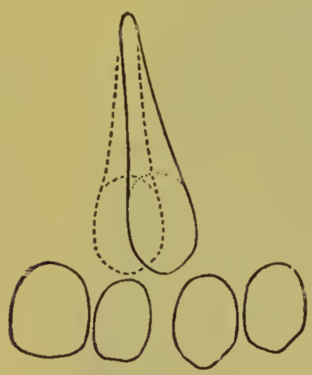

FIG. 204.—Showing the root of the canine lying over the lateral. The dotted lines represent the direction the canine will take if the lateral is extracted.

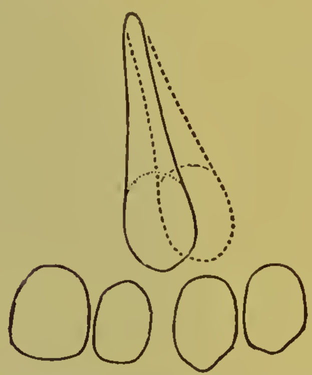

FIG. 205.—Showing the root of the canine lying over the lateral. The dotted lines represent the direction the canine will take if the premolar is extracted.

If the root has a direction forward it is useless to remove a posterior tooth as the canine, when it erupts, will slope very much backwards and look extremely ugly; whereas, if the lateral is extracted, the canine would erupt fairly straight, and give a much better appearance. The accompanying figures illustrate this point.

The question whether a premolar or molar should be removed has been already discussed on p. 115.

Irregularities of the canine seldom require any mechanical treatment, especially if judgment has been exercised in extracting the teeth with relation to the bite. Nature will frequently overcome the difficulties unaided, and it is therefore a good plan in most cases to wait for a period of from three to six months after extrac-

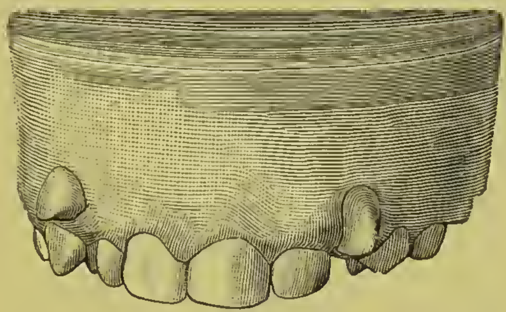

FIG. 206.

tion. If at the end of that period the tooth does not appear to be moving into position, mechanical assistance should be given, and one of the simplest methods in vogue is that shown in fig. 124.

In removing a premolar for the relief of a crowded canine, attention must be given to the position of the corresponding lower

FIG. 207.—Canine teeth removed from the case illustrated in fig. 206.

premolar, for the latter may be situated in such a manner as to prevent the upper canine from coming correctly into line. In certain cases, however, extraction of the canines is quite justifiable, especially in cases where, with the arch regular and the occlusion good, the laterals are close or fairly close to the premolars, and the canines erupt outwards almost at right angles, as seen in fig. 206.

The teeth in such cases usually have twisted roots, which would give rise to difficulty in bringing them into position (fig. 207). Under such conditions extraction is undoubtedly the best treatment.

The eruption of a tooth within the arch may be due to the persistence of its predecessor, or the tooth may have taken an abnormal direction from some unknown cause. Crowding may also be responsible for the irregularity in some instances, and when this is the case there is frequently some rotation of the first premolar. The treatment is to make room either by the removal of the persistent tooth or a permanent one, and then to push the tooth into position by mechanical means.

Fig. 208 illustrates such a case in a patient aged 18. The

Fig. 208.—A case in which the canine has erupted internal to the arch.

crowding was probably the result of early extraction of the deciduous second molar allowing the first permanent molar to encroach upon the premolar space. Treatment consisted in the removal of the first premolar and the roots of the first permanent molar; the canine being brought into line by a strong pianoforte wire spring attached to a vulcanite plate.

(v.) **Cases of crowding resulting in displacement of premolars.**— Displacement of the second premolar internal to the bite frequently results from crowding. When this occurs the premolar has erupted after the canine. Fig. 209 is an excellent example of this type of irregularity. The treatment of such a case would be the removal of the abnormally placed premolars. If, however, the

molars are unsaveable, it would be necessary to remove them and bring the premolars into the line of the arch.

Another variety of irregularity of the premolar is shown in fig. 210. The crowding is caused by the first permanent molar moving orward. In treating an irregularity of this nature one of

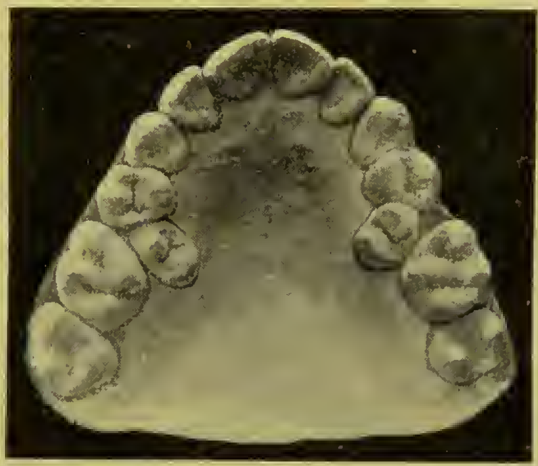

Fig. 209.

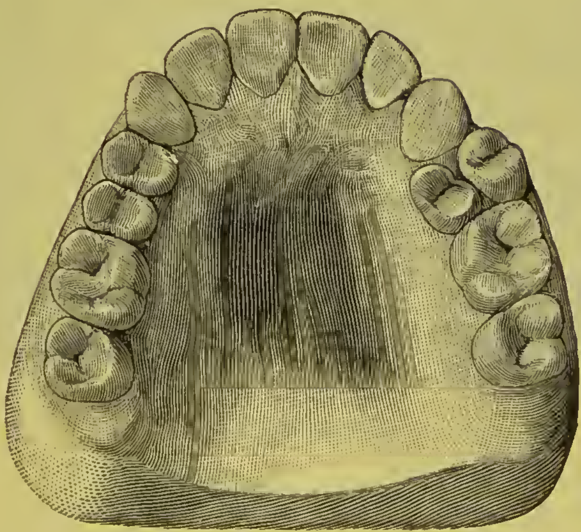

Fig. 210.

the premolars should be extracted, and in selecting the one to be removed the choice should be determined by their relation to the lower teeth and to the amount of rotation.

In the case shown in fig. 211 the irregularity of the premolars

is accompanied by persistence of the second deciduous molar, the latter tooth being quite healthy. The treatment under such conditions is to remove the outstanding premolar.

(vi.) **Crowding resulting in the displacement of a mandibular incisor.**—An irregular arrangement of the mandibular incisors caused by crowding is frequently met with, the canines being mainly responsible for this condition. The canines are normally developed external to the incisors, the crowns often slightly overlapping the labial surface of the laterals ; in instances where there is insufficient room for the development, the canines encroach on the incisior region and so cause irregularity.

FIG. 211.

Crowding of the anterior lower teeth is not so important from an æsthetic point of view as crowding of the upper. The most effective method of treating these cases when the crowding is severe is to remove an incisor. In selecting between the four incisors the following points may influence a decision.

(α) A central should, if possible, be extracted in preference to a lateral, for the reason that the symmetry of the mouth will be

to a certain extent maintained, the laterals being adjacent to the canines with the single central between them. If a lateral incisor be removed the canine on one side will be adjacent to a central, and on the other side to a lateral.

(β) An outstanding tooth should be removed in preference to one instanding, as the latter will be more easily brought into correct line, the pressure of the tongue being more powerful than that of the lower lip.

Fig. 212.

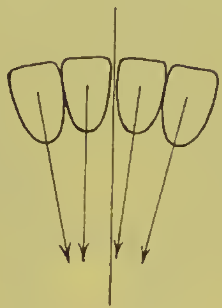

Fig. 213.—Diagram showing directions of the roots of the incisors.

(γ) The direction of the roots of the different teeth must be considered. The tooth selected should permit of the remaining incisors assuming a vertical direction. For instance, in the case shown in figs. 212 and 213, removal of the right central incisor would permit the remaining teeth to assume vertical directions, but removal of the left central incisor would result in the right central incisor assuming a distinct slope.

(vii.) **Mandibular canines.**—Displacement external and internal to the arch may occur, the former being more common. The principles of treatment are similar to those for maxillary canines.

(viii.) **Lower premolars** placed external or internal to the arch, as shown in fig. 214, require removal.

(*e*) **General crowding—treatment of cases involving the malposition of several teeth.**— For general crowding of the teeth three courses are open—extraction, expansion, or a combination of extraction and expansion. The relative merits of these operations have already been considered (p. 113).

Opinions differ as to the correct time to remove the first permanent molars in order to obtain the best results. An examination of mouths in which this operation has been performed would appear to show that the best results are obtained when these teeth are removed prior to the eruption of the second permanent molars, and subsequent to the eruption of the premolars. Under such conditions good spacing between the anterior teeth is obtained, and

FIG. 214.

there is far less tilting of the second lower molars. A strong objection to removing the first permanent molars at this period in crowded mouths is that the second permanent molars (especially the upper) move forward and encroach on the space required for the backward movement of the anterior teeth. In crowded mouths removal of the teeth should not be carried out until the appearance of the second permanent molars. Many practitioners hold that the operation should be delayed until the latter teeth are fully erupted and in good occlusion, on the ground that a great amount of the tilting of the second lower molars is avoided. A disadvantage of waiting until this period is that the irregularity of the anterior teeth becomes more pronounced and the teeth more firmly implanted, so that the crowding is less easily remedied. It there-

fore seems advisable to remove the first permanent molars directly the second molars are sufficiently through to allow of their being held back by mechanical means (fig. 215). In this way the

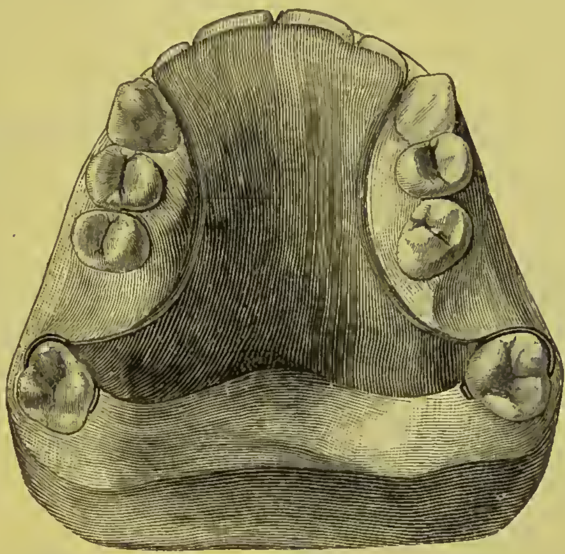

FIG. 215.

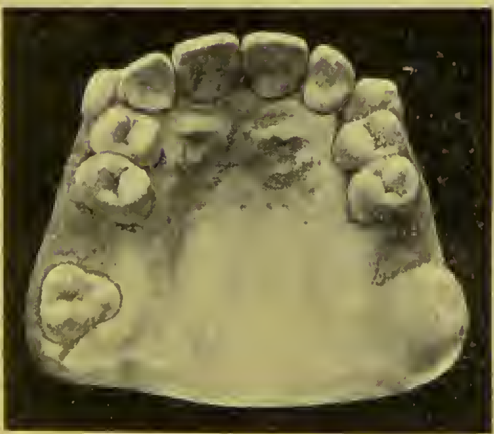

FIG. 216.—Before treatment.

FIG. 217.—After treatment.

crowding can be overcome at an earlier period, and the tilting of the second molars to a great extent prevented.

The disadvantage of removing the first molars before the second is seen in figs. 216 and 217.

A certain number of cases come under treatment in which the

lower first molars have already been removed and no attention has been directed to the upper teeth. The following case is instructive.

Owing to the removal of the lower first molars a year previously the second permanent molars have travelled forward and partly articulate with the first upper molars; the upper left second premolar is displaced inwards, but otherwise there is practically no crowding (see figs. 218 to 220). Some of the upper incisors have been attacked by caries on the approximal surfaces. The left upper first molar has a cavity on the masticating surface, while in the right upper first molar a cavity has been successfully treated on the anterior surface.

The occlusion of the teeth on the right and left sides is diagrammatically shown in figs. 221 and 222.

FIG. 218.

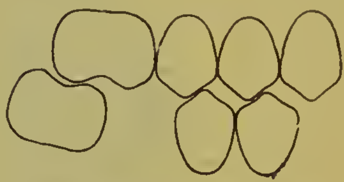

FIG. 221.—Right side.

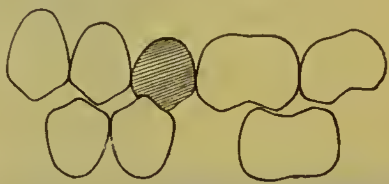

FIG. 222.—Left side.

On the left side it will be noticed that the second upper premolar is internal to the arch. The articulation between the first upper premolar and the lower premolars is not good. The upper first molar is prevented from moving forward by the second premolar and is only half opposed, while its posterior cusps prevent the second lower molar from moving forward. The second upper molar is erupting, hence a posterior force is present. Extraction of the second upper premolar will allow the first upper molar and the second lower molar to move forward, and so lead to an improvement in the articulating surface. On the right side it will be seen that the anterior plane of the first upper premolar only partially articulates with the posterior plane of the corresponding lower tooth, and not at all with the anterior plane of the second lower premolar as it should do. Only half the anterior plane of the second upper premolar is used. The first upper molar is only partially in occlusion with the second lower molar, and this prevents the latter moving forward. The upper second molar is erupting. Extraction of the second upper premolar would permit the first upper premolar to move backwards and articulate correctly with the lower premolars. The first upper molar and second lower molar would move forward and the articulation would be improved. The upper second premolars were removed, and the result is seen in figs. 223 and 224.

In cases where there is marked crowding in the upper, with the maxillary first molars saveable and the mandibular unsaveable, the best results are to be obtained by removal of the mandibular first molars before the eruption of the second molars. The latter will then come forward and articulate well with the upper teeth. The

FIG. 219.—Before treatment. Right side.

FIG. 223.—After treatment. Right side.

FIG. 220.—Before treatment. Left side.

FIG. 224.—After treatment. Left side.

first maxillary premolars should be removed, if possible, before the canines erupt. In this way the crowding of the upper teeth can be correctly overcome and a good articulation obtained. A case thus treated is shown in figs. 225 to 228.

Second premolars should as a rule be removed in cases where the crowding is not great. Should a space remain it will not be so noticeable as if the first premolar had been extracted. Removal of the second premolars is indicated in cases where caries is present on the anterior approximal surfaces of first molars.

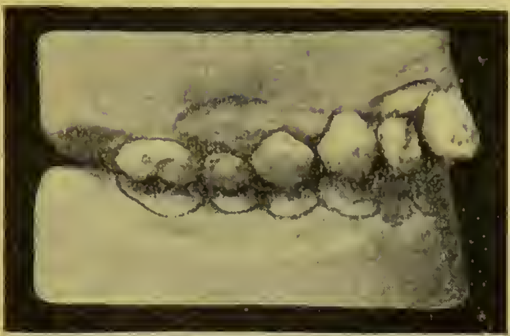
FIG. 225.—Before treatment. Right side.

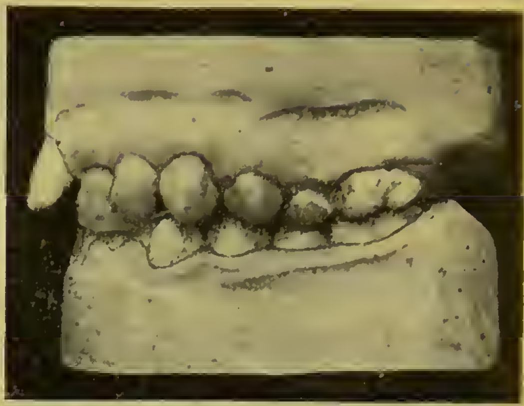
FIG. 226.—Before treatment. Left side.

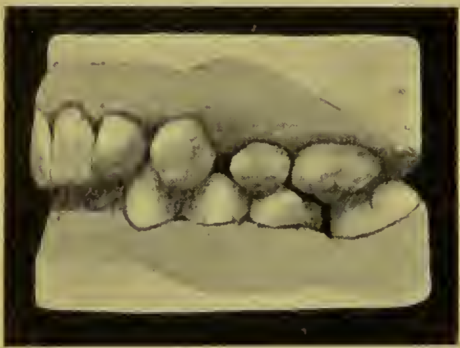
FIG. 227.—After treatment. Left side.


FIG. 228.—After treatment. Right side.


FIG. 229.—Before treatment.


FIG. 230.—After treatment.

The following is an instructive case requiring the removal of the second maxillary premolars :—

The patient was a girl aged 15 years.[1] The upper front teeth were crowded and irregular (fig. 229). The lower teeth presented a good arch. An examination of the premolar and molar occlusion on the right side showed that only portions of the posterior planes of the first and second premolars were in contact

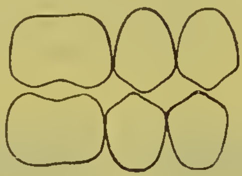

Fig. 231a.

Fig. 231.—Before treatment.

Fig. 232.—After treatment.

Fig. 233.—Before treatment.

Fig. 234.—After treatment.

with the lower teeth (fig. 231). This is diagrammatically shown in fig. 231a. Removal of the first upper premolar would allow the second premolar to come forward and occlude with both lower premolars, and at the same time allow

[1] This case was under the care of Mr. J. Ackery.

room for the canine to move backwards, but the second premolar on this side was carious. With removal of the second premolar the first premolar could be brought back and made to articulate satisfactorily with the lower premolars, and the crowding of the front teeth would be overcome. On the left side (fig. 233) the second lower premolar has not erupted, and there are no signs of its presence. The second upper premolar therefore forms but a small portion of the masticating area, and is consequently the tooth to remove.

The treatment consisted in the removal of the second upper premolars. The first premolars were then brought back by mechanical means. A vulcanite plate capping the molars and premolars was then made, half round gold wires

Fig. 235.—Before treatment.

Fig. 236.—After treatment.

Fig. 237.—Before treatment.

Fig. 238.—After treatment.

being attached to the sides and arranged so as to bring pressure on the mesial angles of the right central and tho left lateral. Opposite the palatal aspect of the left central a wedge of compressed wood was inserted and the tooth brought forward. By a similar arrangement the distal anglo of the right central was driven forward. A retention plate was used for twelve months. The result is

seen in figs. 230, 232 and 234. A regular arch has been obtained. The occlusion of the teeth on the right side has been improved. On the left side the occlusion has not been impaired, and will be improved when the molars move forward.

The operation of expansion may be adopted in cases where the general lie of the premolars and molars is inwards, and where the articulation and the personal appearance of the patient will be improved by the operation. A case treated by expansion is shown in figs. 235 to 238.

FIG. 239.—Before treatment.

FIG. 240.—After treatment.

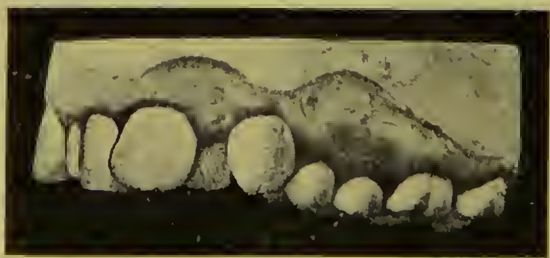

FIG. 241.

In a few cases the removal of a lateral incisor on one side and a premolar on the other may be necessary. The following is an example:—

In this patient, a girl, the anterior upper teeth were crowded, the lateral incisor on the left side being internal to the arch (fig. 239). In the lower the arch was regular, but the lower central incisors were absent. The teeth were free from caries. An examination of the roots of the left central and lateral

incisors and canine showed that the root of the central sloped in a backward direction, and was placed in a plane anterior to the root of the lateral. The crown also overlapped that of the right central. The direction of the canine root was very slightly backward, and was also in a plane anterior to the lateral. The positions of the three teeth are shown in fig. 241. The occlusion of the premolars and molars was good (fig. 242). On the right side the root of the canine was directed backwards, and the crowding of the central and lateral incisors was slight. The relation of the upper to the lower premolars and molars is shown in fig. 244. In considering the treatment of this case one was met with the difficulty of marked crowding on one side and but slight crowding on the other. On the left side two courses were open: (*a*) the removal of the first premolar or a tooth posterior; (*b*) the removal of the lateral incisor. If removal of the first premolar were carried out the canine would need to be retracted and the lateral incisor pushed out. The result of this operation would probably result in the canine assuming a very sloping direction and being short, the

FIG. 242.—Left side, before treatment.

FIG. 243.—Left side, after treatment.

lateral having its cutting edge tilted forward, while the central would be driven still more across the median line. In addition, the treatment would require the prolonged use of a plate, and there would be a constant tendency to relapse. On the other hand, removal of the lateral incisor would permit the central to fall back and assume a more vertical direction, the canine would move forward and fill up the gap. There would be true relief of the crowding (both roots and crowns), and no tendency to relapse. On the right side but little room is required, and removal of the lateral to correspond with removal of the left lateral is out of the question. The treatment, therefore, resolves itself into the removal of a premolar or molar. The molar is free from caries, so that a choice must be made between the first and second premolars. Removal of the first premolar would in all probability result in a gap between the canine and the second premolar. Removal of the second upper premolar alone, and retraction of the first premolar would also leave a gap, because the first premolar would eventually occupy the same position as the second premolar.

Removal of the lower second premolar as well as the upper second premolar would allow the first premolars, upper and lower, to move back sufficiently to overcome the crowding of the incisors and canine, while the molars would move forward and assist in filling up the gap. In addition, mechanical methods would be avoided. Treatment consisted in the removal of the left upper lateral incisor and the right upper and lower second premolars. The result of treatment is seen in figs. 243 and 245. On the right side a slight gap has resulted between the premolar and canine, but when last seen the molars had moved still more forward and had considerably improved the occlusion of the upper premolar with the lower premolar and first molar. With the advent of the third molars the space will, no doubt, be entirely closed.

Fig. 244.—Right side. Before treatment.

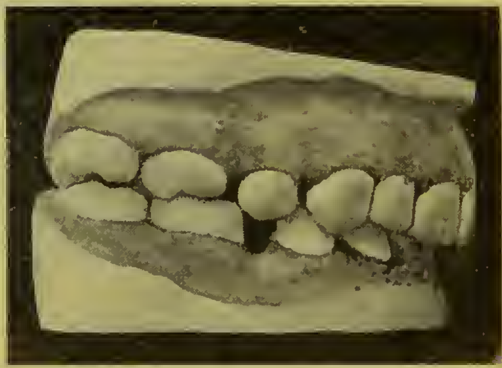

Fig. 245.—Right side. After treatment.

(G) UNDUE PROMINENCE OF THE UPPER FRONT TEETH—SUPERIOR PROTRUSION.

An abnormal projection of the upper front teeth is usually known as superior protrusion. In the majority of cases the lower lip, when the mouth is in repose, passes behind the upper teeth, and as the upper lip fails to completely cover them they remain continually exposed, producing what is often a most unsightly appearance. The prominence may be limited to the central incisors, but in the larger proportion of cases the lateral incisors and also the canines are involved.

(1) CAUSES.

(*a*) **Habits.**—The cause in a few instances can be traced to thumb or finger sucking. In this habit the palmar surface of the thumb is placed against the palatal surfaces of the central incisors, the mandibular teeth being closed on the dorsal surface; the

pressure exerted causes the central incisors to protrude so that the lower lip passes behind them and aggravates the protrusion when the mouth is at rest. In some cases the thumb or finger is inserted between the teeth causing the teeth to impinge on the lateral surfaces.

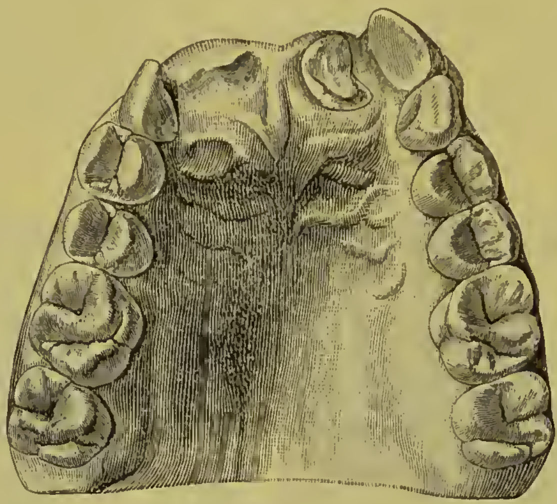

Fig. 246.—The supernumerary teeth removed from this case are shown in fig. 28.

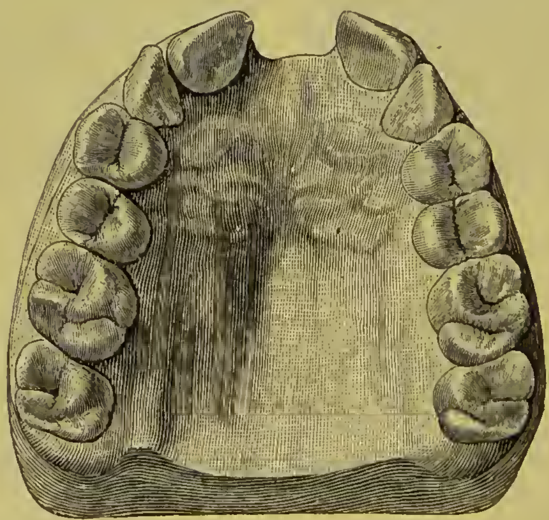

Fig. 247.—The case shown in the preceding fig., six months after the removal of the supernumerary teeth.

Under such conditions the upper lateral incisors and also the canines are forced outwards and frequently upwards, producing a type of "open bite." The habit of constantly sucking the lower lip or tongue may produce protrusion of the upper teeth, and in the

case of a patient under the care of Mr. F. Ewbank, the two central incisors had been protruded by the habit of "toe sucking."

(*b*) **Causes connected with the maxilla.**—In a few instances the deformity may be traced to an **excessive development of the anterior part of the maxilla,** and may be confined to the alveolar process or may involve the whole body of the bone. In some instances the protrusion can be distinctly traced to a **crowded condition of the teeth,** the canines during development and eruption forcing the incisors forward. In other words, the same forces which lead to and produce general crowding of the incisors and canines may under certain conditions cause superior protrusion, the form of irregularity which the crowding takes being influenced by the relative position of the developing teeth in their alveoli.

Supernumerary teeth may cause superior protrusion (figs. 246 and 247). The extra teeth may erupt posterior to the incisors and so force the latter forward, or the supernumeraries may wedge themselves between the incisors and the canines. The attachment of the **frænum of the upper lip** to the inner aspect of the alveolus has been alluded to on page 69, and is a possible factor in starting the protrusion of one or both central incisors.

Many cases of superior protrusion are accompanied by a **narrowing of the arch.** G. G. Campion, who first drew attention to this fact, found that the average width of twelve normal arches was 46·9 mm., while in twenty-six cases of superior protrusion the average was only 41·3 mm., or a difference of 5·6 mm.

The incisor teeth will also be found to assume a direction more sloping than the normal, the slope being more marked after the eruption of the permanent canines.

An abnormal occlusion of the teeth is often met with.—The whole of the maxillary teeth frequently bite in advance of their normal position. Mr. Campion found in thirty-nine cases of superior protrusion that in four, or just over 10 per cent., the molar and premolar occlusion was normal on both sides; in twenty-four cases, or about 61 per cent., the maxillary teeth were the whole breadth of a premolar in front of their normal position, while in the remaining cases the articulation varied on the right and left sides of the mouth, and in some the molars and premolars met cusp to cusp, or half the breadth of a premolar posterior to the normal bite.

This abnormal articulation of the teeth is not peculiar to superior protrusion, it is found in other conditions of crowded teeth, and

occasionally with the deciduous teeth. The production of superior protrusion in one instance, and a crowded condition of the incisor teeth in another, may, as pointed out above, be due to the position of the teeth during development.

(*c*) **Causes connected with the mandible.**—An **arrest of the development of the mandible** will also cause the upper front teeth to be unduly conspicuous, but such a condition can hardly be termed superior protrusion. The **mandibular incisors are generally higher than usual, and are often arranged in a fan-shaped manner.** In many cases they rise high enough to press on the cingula of the

Fig. 248.[1]

maxillary incisors. This pressure tends to force these latter teeth outwards and produce a type of superior protrusion. This rising up of the mandibular incisor teeth is a most important factor in the deformity, and is probably caused by the canine pressing on the roots of the incisor teeth through want of room in the mandible. That the pressure of the canine is a powerful factor in the production of this condition is well shown in fig. 248, which is taken from a skull in the Museum of the Odontological Society. A recognition

[1] From the *Transactions of the Odontological Society.*

of this point is important in treatment, as it indicates that in order to overcome the uprising the pressure must be relieved.

Complicating some cases of superior protrusion there is an apparent shortness in the molar region, and this, according to Mr. C. S. Tomes, is probably accompanied by a rectangular ascending ramus of diminished length. Mr. Tomes states that if we have the latter with short grinding teeth coincident with well developed incisors, it is not difficult to see that the upper front teeth will be driven outwards by the lower.

(*d*) Too early removal of the first permanent molars, with premature loss of the deciduous molars, will at times produce undue prominence of the upper teeth by throwing the whole force of the bite on to the lower incisors and the cingula of the superior teeth.

That a predisposition to superior protrusion may exist is beyond doubt, as it is a condition which at times can be traced through whole families. Again, it is quite possible that the narrowness of the maxilla is influenced in a great measure by the general development of the cranial bones, for frequently the narrow arch is in keeping with the general features.

Some dental surgeons are of opinion that the protrusion does not increase after the complete eruption of the incisors, but an examination of the models of cases before and after the eruption of the canines will show that this theory is untenable.

(*e*) Superior protrusion is frequently accompanied by a short upper lip, and it is interesting to speculate whether the shortness of the upper lip contributes to the deformity, and if so, to what extent. Under normal conditions the pressure of the upper lip on the labial surfaces of the teeth counteracts to some extent any force which tends to drive the teeth outwards. If, however, the upper lip is short, this counteracting pressure is diminished or altogether absent, and the forces acting on the teeth from within the oral cavity probably cause the teeth to project.

(*f*) In young adults suppurative periodontitis is also to be cited as a cause of protrusion of the upper incisors.

Protrusion of the upper front teeth is at times seen in the first dentition, and with an extended knowledge of young children's teeth it will probably be found that irregularities of this kind are more common than is generally supposed.

(2) TREATMENT.

(*a*) General points.—In thinking over the various pros and cons of any special case the following points should be taken into consideration.

(i.) **Whether the condition is limited to the alveolar portion of bone or involves the body of the maxilla as well.**—In the former case a good result may be anticipated provided rational measures are adopted. If the body of the maxilla is involved the condition is less amenable to treatment and a satisfactory result from an æsthetic point of view is difficult to obtain. The features in such cases are often moulded in keeping with the prominent teeth, and the result of retracting them is to produce an undue flatness of the upper lip, and so to a great extent mar the facial expression.

(ii.) **Development of the air sinuses.**—At the age when cases of protrusion come under observation, the air cells, such as the antrum and frontal sinuses, are only partially developed, but with the advent of puberty a rapid increase in their size takes place, with the result that the upper part of the face becomes more prominent and to some extent masks the protrusion of the teeth.

(iii.) **The condition of the teeth** is of great importance because mechanical means must of course be adopted for retraction and retention, and the prolonged use of mechanical appliances with weak teeth is certain to predispose them to caries. Whether the gain to appearance outweighs the harm which is likely to accrue from treatment is therefore a question which must receive careful attention. When caries is already present on the approximal surfaces of the incisors, mechanical treatment should only be adopted if the deformity is very marked.

(iv.) **The occasional tendency to improve with age.**—This is seen more especially where the lower incisors impinge on the cingula of the upper teeth. The "bite" of the molars and premolars in such cases probably becomes lengthened, with the result that the lower lip fails to fall behind the upper teeth, and the pressure of the lower on the upper incisors is also relieved. The opposing forces being thus removed the upper lip is able to bring the teeth back, providing that there is sufficient room in the arch. That improvement in a few cases does take place in this way is unquestionable, but it is only likely to occur where the protrusion is slight.

Providing the action of such causes as the lower lip, the lower

incisors, and crowding of the upper canines and incisors is overcome, the case will not relapse if a retention plate is worn for a sufficiently long period. The removal of the crowding of the roots as well as of the crowns of the teeth is most important, and is frequently overlooked. If the crowns only are relieved the teeth will show a distinct tendency to resume their former positions.

This tendency is also seen in cases where the lower incisors bite behind the cingula of the upper, and is then often due to the fact that the pressure of the canines on the lower incisors has not been relieved, the consequence being that the latter are constantly being forced upwards.

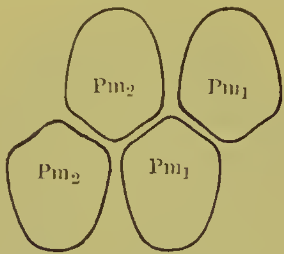

FIG. 249.—Diagram of articulation of superior protrusion cases which often require retraction of the upper premolars.

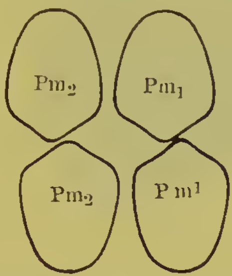

FIG. 250.—Diagram showing the least extent to which upper teeth must be retracted. The posterior plane of the lower teeth will tend to drive the upper teeth backwards.

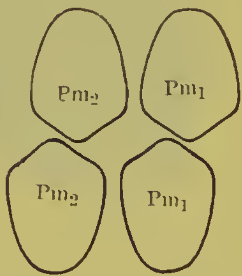

FIG. 251.—Diagram showing an insufficient amount of retraction of upper teeth. The posterior planes of the upper teeth will tend to drive the lower teeth backwards and so cause the abnormal articulation of premolars to persist.

The details of treatment can be best described by considering some examples of the more common types of superior protrusion met with in practice.

(*b*) **The mechanical methods of retracting teeth.**—The teeth can be easily and correctly retracted in many ways, and the method adopted by individual practitioners is usually the result of custom and fancy.

The premolars can be drawn back with a plate similar to that shown in fig. 128. It is important that the plate should occlude correctly with the lower teeth. In this way the rigidity of the plate will be considerably assisted. It is advisable to retract only one premolar on each side at a time. If both premolars are retracted simultaneously the second molar is very likely to move forward, as the resistance offered by two premolars is frequently greater than that of one molar, especially if the latter is not fully erupted. The premolars should be moved back far enough to allow the anterior planes of the upper teeth to strike the posterior planes of the lower teeth, otherwise the posterior planes of the upper teeth will tend to drive the lower teeth backwards and so cause the abnormal articulation to persist. (See figs. 249 to 251.)

FIG. 252.

The canines can be retracted with an appliance similar to that seen in fig. 124. In adjusting the wires care should be taken to obtain a direct pull back and avoid pressure on the labial surface, otherwise the teeth will be driven towards the palate. As the canine teeth offer a considerable amount of resistance the vulcanite plate should cover the premolars and molar in order to obtain a sufficiently firm hold.

The incisors may be treated by means of a plate similar in character to that shown in fig. 252. The wires should be made of gold (half round), they should extend to the mesial border of each central, and when adjusting them to the teeth pressure should be exerted on the mesial rather than on the distal half of the tooth.

If the pressure falls on the latter the wires will tend to force the teeth towards the median line and cause them to overlap. Gold wire as a means of retracting teeth has the advantage of being easily bent and so brought to bear upon any part of the tooth, and in practice is found to answer admirably. This form of plate is simple, requires no attention on the part of the patient beyond that of cleaning, and is less unsightly than most other appliances.

Another method of retracting teeth which is found in practice to work very well is shown in fig. 253. The plate, however, should be made so as to cap the first permanent molars.

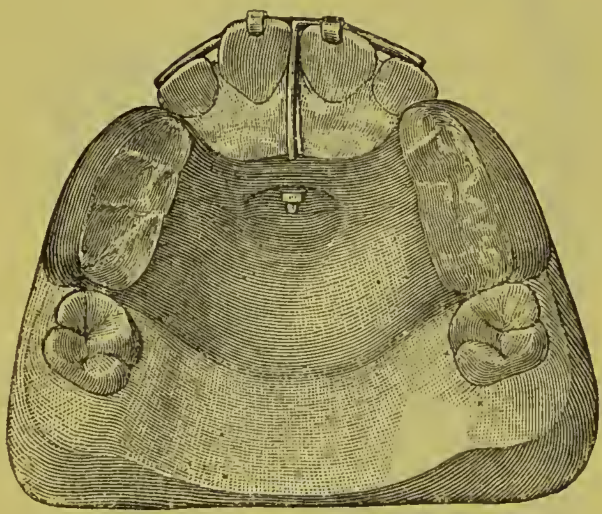

FIG. 253.

Many practitioners utilise the elastic property of rubber as the retractile force. A vulcanite plate is made covering the posterior teeth and a strip of rubber dam is stretched across the front teeth, the rubber being buttoned on to the sides of the plate. If the rubber is brought below the cutting edges of the teeth it curls round them, acquires a firm hold and has no tendency to slip upwards. It is claimed for this method that in addition to being brought back, the teeth can also be forced upwards into their sockets provided the buttons are placed high enough in the plate. It must, however, be borne in mind that forcing up the teeth generally means absorption in the neighbourhood of their apices, which is most undesirable.

In the foregoing methods the fixed point has been obtained directly or indirectly from the posterior teeth. With some practi-

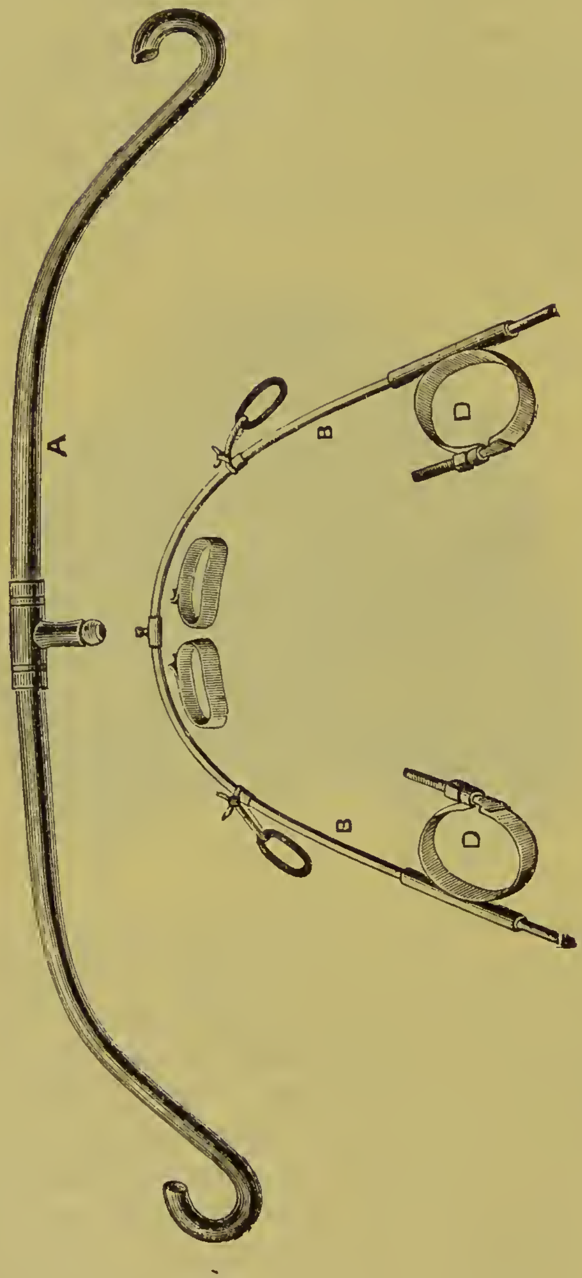

FIG. 254 (Angle).

tioners the occiput is employed as the point of resistance. The most useful of these methods is that known as Angle's. The appliance is shown in fig. 254. The bands D are fixed around the first molars, the ends of the labial band passing through tubes soldered to the buccal sides of the molar bands. The anterior part of the labial wire is held in position by bands encircling the central incisors. Notches are formed in the united ends of the bands upon the mesio-labial surfaces, and in these the labial wire rests. The occipital cap is shown in fig. 255, and the force is transmitted to the wire arch in the mouth by elastic bands attached

FIG. 255 (Angle).

to the traction bar (fig. 254 A.) When the headgear is not in use the little elastic bands shown in fig. 254 B are slipped over the ends of the tubes on the molar bands and so keep up a slight tension in a backward direction. It is claimed by Dr. Angle for this method "that not only is the prominence of the teeth reduced, but the malposed teeth are gradually forced to take regular positions and conform to the shape of the ideal arch as it is forced backward through the tubes on the molars, an action impossible with dividers having fixed caps of vulcanite or gold."

All cases of superior protrusion which have been corrected require the aid of a retention plate for a period varying from six months

to a year. A useful form of plate is shown in fig. 130. The tendency of the wire to slip towards the gum margin may be overcome by soldering to it a tag which passes over the cutting edge of one of the incisors. If the wire is not kept firmly in its place the teeth in their tendency to relapse will force the wire in an upward direction.

(*c*) **Cases where the teeth have been protruded from such habits as finger and thumb sucking** present little difficulty as a rule. There is usually ample space in the arch, and the only treatment needed is to retract the teeth and retain them in position for a period of about six months. The retraction can be accomplished by means of a plate similar to that shown in fig. 252.

FIG. 256.

(*d*) **Cases where the whole body of the maxilla is prominent** will require considerable judgment in deciding on the treatment. Generally speaking they are best left alone for the reasons given on p. 150. In a few instances partial retraction may be beneficial, but the extent to which the teeth may be drawn backwards must depend upon the facial expression. It is often, however, advisable to relieve any pressure that may be present by extraction. In this way the protrusion will be prevented from being increased by the force of eruption of the third molars.

(*e*) **Cases where the alveolar process is alone involved and the lower teeth do not impinge upon the palatal surfaces of the upper.** The models shown in fig. 256 illustrate a variety belonging to this class. The upper teeth are in a fairly regular arch, but the pre-

molars and molars are abnormally placed in relation to the lower teeth. The fault is entirely with the maxilla, the mandible apparently being normally developed.

(i.) **Removal of premolars.**—Provided that the first permanent molars are saveable, the treatment in such a case would be the extraction of the first upper premolars, followed by the retraction of the canines, and subsequently the retraction of the incisors.

In a case similar to that shown in fig. 257 the lower as well as the upper premolars must be removed. The necessity for removing the lower arises from the fact that the lower canines are prominent, owing to a certain amount of crowding, and if the upper premolars only are removed, the lower canines when they are retracted will

FIG. 257.

cause the upper canines to be unduly prominent. The removal of the lower premolars will enable the canines in the mandible to move back, and at the same time inwards, and so allow the upper teeth to assume a correct position.

(ii.) **Removal of first permanent molars.**—If in a case similar to fig. 257 the first molars are unsaveable, they must be removed. The extraction of the upper teeth may be undertaken as soon as the second permanent molars are sufficiently through to allow of their being retained in position by means of a splint plate (fig. 215). This plate, as before mentioned, will prevent the second molars from moving forward, and will allow them to fully erupt. It will also permit the premolars to travel back, provided that the bite of the lower incisors in the plate is so arranged that the premolars, upper and lower, are separated from one another during occlusion. No

attempt should be made to move back the premolars by mechanical means until the second permanent molars are firmly implanted, as the molars are liable to move forward if mechanical force is used too early.

The lower first molars should be retained until the premolars in the upper occlude with the posterior planes of the corresponding lower teeth. The lower first molars may be removed then or at the completion of the retraction of the front teeth.

(iii.) **Jumping the bite.**—The operation of "jumping the bite" is recommended by some practitioners as a method of dealing with the variety of protrusion under consideration. In the case fig. 256, the lower premolars and molars are nearly the width of a premolar behind their correct articulation. If by any means the patient can be made to acquire the permanent habit of bringing the mandible forward so as to make the teeth articulate normally, the bite will have been "jumped." The subject is one which has been largely written upon, and on which there is much diversity of opinion.

Dr. Ottolengui,[1] who claims to have "jumped the bite" on many occasions, adopts the following plan:—"The frontal prominence of the superior jaw having been reduced as much as is possible, the lower jaw is moved forward to a good occlusion with the anterior part of the jaws, little consideration being given to the posterior teeth. The lower jaw must not be progressed, however, beyond what becomes a part of the best facial contour, especial observation being given to the pose of the lips and the relation of the chin to the rest of the features. As soon as it is decided just where it is most desirable to have the lower jaw, a plate is made which snugly fits the roof of the mouth, and which has, at the anterior part, an inclined plane, which not only prevents the closure of the mouth in the old position, but by catching the tips of the lower teeth causes them gradually to slide forward in closing, so that the mouth shuts in the desired pose. This plate is worn until the habit becomes fixed. The new bite may become a new habit in two or three months, and a child may adopt it in less time, without the inclined plane and with nothing whatever to produce the change except an indomitable will power and sufficient interest in her own welfare to second the efforts made on her behalf."

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[1] *The Dental Practitioner and Advertiser*, vol xxv., p. 194.

It is clear from the cases recorded that patients can be made to acquire, at least temporarily, the habit of protruding the jaw, and so "jumping the bite." Does this habit become permanent, and if so, what structural changes take place in the parts involved? By some[1] it is maintained that the changes are accomplished in the glenoid cavity (1) by an extension of the condyle on the lower jaw, which practically amounts to a bending backwards of the neck; (2) by the filling up of the cavity posterior to the condyle. These explanations do not seem compatible with our knowledge of the anatomy and physiology of the temporo-mandibular articulation. A more probable explanation is that the teeth move forward in the sockets. When the teeth are occluded in the new position,

Fig. 258.

namely, with the bite jumped, there must be a constant tendency on the part of the muscles to retract the mandible to its old position; this backward tendency is arrested by the upper teeth, with the result that the lower teeth are drawn forward in their sockets, absorption and redeposition of bone in the tooth sockets take place as when a tooth is moved by mechanical means. It would be interesting to obtain accurate illustrations of cases taken some years after treatment, as the direction of the teeth might assist in elucidating this point.

(iv.) **Removal of lateral incisors.**—The model shown in fig. 258

[1] *Transactions of the World's Columbian Dental Congress*, vol. ii., p. 760.

illustrates a type of protrusion which requires for its correction the removal of the lateral incisors. It will be noticed that the canines and incisors are in a crowded condition, the roots of the canines being directed towards the median line, and the roots of the lateral incisors being covered partly by the canines and partly by the centrals. In such a case, if the premolar or molar were removed the canine would only travel back to a slight degree, and would assume a sloping direction. In all probability the canine would be short, and owing to the root of the central overlying the lateral, it would be extremely difficult, if not impossible, to bring the teeth into anything like a correct or regular arch. Although the irregu-

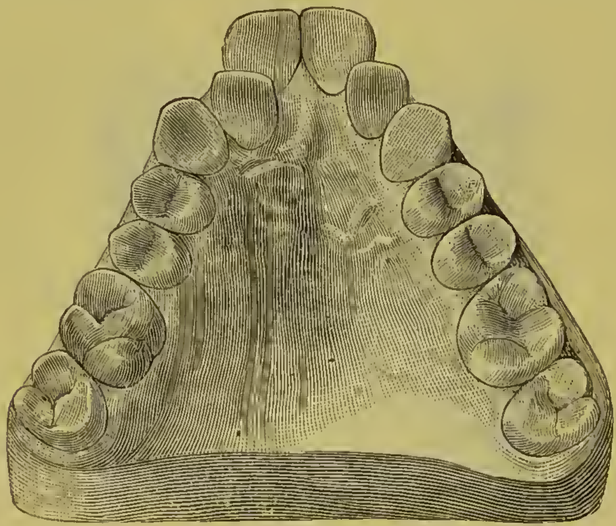


FIG. 259.—A case of superior protrusion which should be treated by removal of the lateral incisors.

larity of the crowns might be overcome, the apical ends of the roots would still be crowded and predispose the case to relapse. On the other hand the removal of the lateral incisor would allow the canine to erupt to its correct length and assume a vertical direction. The central incisor could be easily retracted and also brought into correct alignment. Crowding of the apical portions of the roots would be overcome, and there would be but little tendency to relapse. The result of treatment in this case was entirely satisfactory. A regular arch was obtained, with the teeth in good direction. There has been no tendency to relapse. If the laterals had been retained, in all probability the arch would not have been brought into such a good

curve, the teeth would have assumed a sloping direction, and there would have been a constant tendency to relapse.

(*f*) Cases where the alveolar process is alone involved and the lower incisors impinge on the cingula of the upper incisors, or on the gum posterior to these teeth. These cases are difficult to treat, and the results obtained are frequently unsatisfactory. If the mouth of a patient presenting this form of superior protrusion be examined, it will be noticed that the lower incisors are on a higher level than the premolars and molars. This may be due to some abnormal condition of the incisors, the height of the premolars and molars being normal; or the incisors may be normal in their arrangement and the premolars and molars unduly short; or again, both incisors, premolars and molars may be at fault. In order that treatment may be successful it is essential that the lower incisors should not impinge on the cingula of the upper incisors when the latter have been retracted. It is therefore needful that attention should be directed to the treatment of the lower teeth. It has already been pointed out that the abnormal uprising of the lower incisors is due to crowding from lateral pressure of the canines, and that the shortness of the range of the molars and premolars probably arises from a defect in the development of the ascending ramus. As a first step in treatment most practitioners endeavour to raise the bite — in other words, induce the molars and premolars to elongate and so prevent the lower incisors from impinging upon the cingula of the upper teeth. There are two strong objections to treatment by raising the bite: (i.) the obstinacy, at times, on the part of the molars and premolars to rise; and (ii.) their liability to relapse by being forced down again into their sockets. It is not surprising that disappointments attend the practice of "bite raising," since the treatment is not in accord with our anatomical knowledge of the condition. Failure to raise the bite seems more likely to occur in cases where the molar and premolar region is well developed. There is a common impression that if teeth are separated from one another they will always elongate. That this is erroneous will readily be seen by a study of that type of irregularity called "open bite." When the ascending ramus is short the premolars and molars are probably prevented from rising to their normal height. If, therefore, the jaws are separated the teeth will no doubt rise. It is in these cases that the liability to relapse occurs. Raising the bite does not affect in any way the ascending ramus, which is the real cause of trouble.

The mouth is in reality propped open artificially, and the muscles which close the mandible are in a state of tension. As soon as the plate is removed the muscles have again free play, and the pressure they exert drives the premolars and molars back to their original positions.

In a few cases, with the eruption of the second molars the bite becomes raised by natural means, probably from a rapid growth of the ascending ramus about this period. It is possible that cases in which raising the bite by artificial means has been permanent, the same natural causes have been at work.

More reliable results can be obtained by directing treatment to the mandibular incisors.—Where the incisors and canines are not very crowded, their cutting edges should be ground down until they are clear of the upper teeth; at the same time it is most important that all lateral pressure should be relieved by the removal of a premolar or molar. If this is not done, there is a risk that when the third molars erupt they will exert a forward pressure and cause crowding of the front teeth. Where the incisors are very crowded, with the canines lying slightly anterior to the laterals, or where the fan-shaped arrangement is well marked, it is an excellent plan to remove an incisor. The crowding of the remaining teeth is efficiently relieved and the incisors usually fall to their normal level and are so prevented from impinging upon the upper gums or teeth. Removal of an incisor slightly narrows the lower arch, and this is, in my opinion, a distinct gain as far as treatment is concerned. Some, however, maintain that the narrowing of the arch may be detrimental to the facial expression because it will allow the lower lip to fall in. This view is incorrect. The prominence of the chin is governed by the mental process, and is in no way dependent upon the alveolar portion of the jaw, which is alone involved in the removal of an incisor. When the upper teeth have been retracted the lower lip should close outside them, and should not be dependent upon the arch of the lower incisors for its position. A case treated in this manner is shown in figs. 260 to 265.

The amount of protrusion is shown in fig. 260.

An examination of the models shows that the right upper premolars are erupting normally as regards occlusion with the lower teeth; on the left the upper premolars are not quite half a tooth in advance of their correct positions, the anterior planes of the upper teeth just striking the posterior planes of the lower teeth. The lower incisors are crowded and show the typical heaped-up appearance already alluded to (fig. 262). The cutting edges of these lower

FIG. 260.—Before treatment.

FIG. 261.—After treatment.

FIG. 262.—Lower incisors before treatment.

FIG. 263.—Lower incisors after treatment.

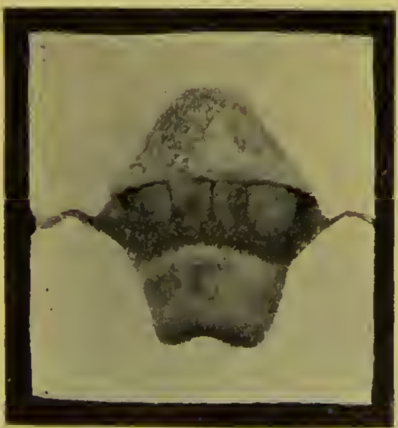


FIG. 264.—Showing relation of the lower incisors to the upper teeth at the commencement of treatment.

FIG. 265.—Showing relation of lower to upper incisors after treatment.

incisors strike the gum just posterior to the upper incisors (fig. 264). The direction of the roots of the lower incisor teeth indicated that the left central should be removed.

This tooth having been extracted the case was left for a year, as the first permanent molars, which were unsaveable, had to be removed, and this could not be done when the patient was first seen as the upper second molars had not then erupted.

When examined one year afterwards the gap caused by the removal of the lower central had closed up, the teeth had apparently dropped down to a lower level (see fig. 263), and were quite free from the upper gum. By the removal, therefore, of this central tooth one of the great difficulties in treating this type of case had been overcome. The first permanent molars were now extracted and a splint plate put in to keep the second permanent molars from moving forward, and at the same time allow the premolars to travel back. The canines were then retracted and the incisors brought in by a plate similar to that shown in fig. 252. The result is seen in figs. 261 and 265. The lower incisors are quite clear from the upper teeth and the lower lip also passes in front of them. The upper teeth could have been retracted still more, but it was not considered advisable from an æsthetic point of view.

(*g*) **Early treatment.** — Early treatment should be pursued wherever possible. The advantages gained are:

(i.) The irregularity to be dealt with at an early stage is less in degree, for if treatment is delayed until after the eruption of the second molars, the canine, in forcing its way into position in the full arch, will exert a forward pressure on the incisors, and thus considerably augment the irregularity.

(ii.) The mechanical treatment of the case is considerably reduced.

(iii.) The articulation of the teeth is less disorganised.

The case shown in figs. 266 to 270 is an example of this line of treatment.

The patient was aged 10 years. The first premolars were removed directly the canines showed signs of erupting. The case was then left entirely alone until the canines had fully erupted, when the incisors were brought in, with the result seen in figs. 267 and 268. The models shown in figs. 269 and 270 give some idea of the amount of protrusion which was overcome by extraction alone.

(H) PROTRUSION OF THE MANDIBULAR INCISORS—UNDERHUNG BITE—INFERIOR PROTRUSION.

In this condition, when the mouth is closed, the upper front teeth pass within the arch of the lower teeth instead of external to them; the chin is unduly prominent and the upper lip is often short. This abnormal arrangement of the teeth may be limited to the

Fig. 266.

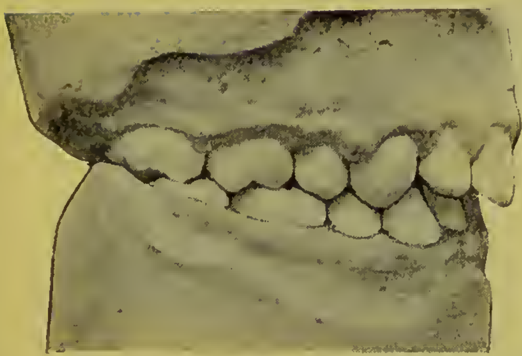


Fig. 267.

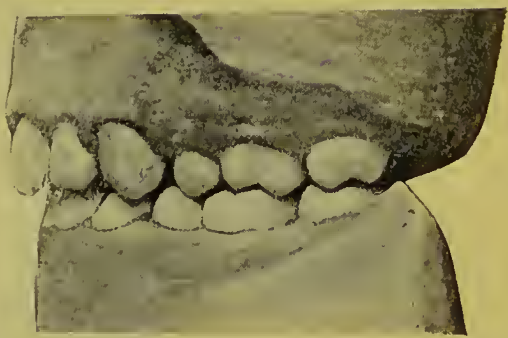


Fig. 268.

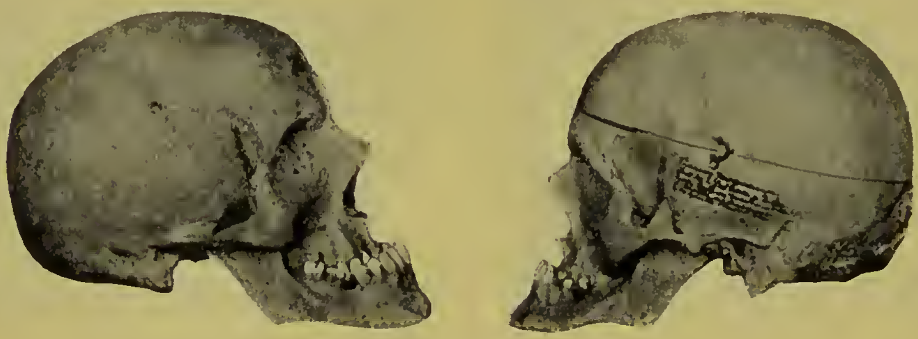
Fig. 269.

Fig. 270.

incisors and canines, or it may involve the premolars and molars as well. Protrusion of the mandible is a natural condition in the edentulous.

(1) *Causes.* (*a*) Habits.—Protrusion of the anterior lower teeth may result from the habit acquired by some children of hooking the fingers over the teeth, and so exerting pressure in an outward direction. The protrusion may be traced to a constant habit of protruding the mandible.

(*b*) Causes connected with the mandible. An excessive development of the whole of the mandible may occur. More often the error in development is limited to the ascending ramus. Under this latter condition the ascending ramus assumes an oblique direction, and causes the horizontal ramus to be pushed forward. This is



(*a*)

FIG. 271.[1]

seen in fig. 271. In the one marked (*a*) the mental process is unduly promineut—a condition not unfrequently seen in these cases. These abnormal developments are frequently hereditary.

Protrusion of the lower teeth at times commences with the eruption of the mandibular third molars. Two instances of this have come under my notice. The contraction of scar tissue in the front part of neck may exert traction on the front part of the mandible and so draw the teeth outwards and downwards.

(*c*) Causes connected with the maxilla.—The mandible may be quite normally developed and the protrusion of the teeth due to an error in the formation of the maxilla. At times the whole maxilla is arrested in its development, and under these conditions the arch

[1] For these illustrations I am indebted to Dr. Grevers, of Amsterdam.

of the teeth falls within that of the mandible. The alveolar portion alone may be involved; under such condition, the molars and premolars occlude correctly, but the superior incisors fall within the arch of the inferior incisors. In a few cases the superior teeth have been deflected in their course by the presence of septic deciduous teeth.

(2) *Treatment.* (*a*) **Cases due to habit.**—If arising from the habit of traction on the teeth, the mandibular incisors may be brought into correct position by mechanical means. A plate capping the mandibular premolars and molars with a half round gold wire impinging on the labial surfaces of the protruding teeth is usually sufficient.

FIG. 272 (Angle).

If the protrusion is due to constant thrusting forward of the mandible, the child must be broken of the habit and a skull and chin cap, similar to that shown in fig. 272, worn day and night. Cases of this type are curable.

(*b*) **Cases due to faulty mandible.**—The treatment adopted must depend in a very great measure upon the cause and extent of the deformity; due regard being paid to the facial expression. Treatment is practically out of the question, excepting where the protrusion is slight. If treatment is decided upon, it should be carried

out on the lines of (i.) expanding the arch of the upper teeth, (ii.) decreasing the arch of the lower teeth. The former can be accomplished by means of an expansion plate, the latter by retracting the teeth after the removal of an incisor or the first premolars. By this treatment it is often possible to make the arch of the maxillary teeth pass beyond that of the mandibular teeth, and slight improvement in the expression may be gained, but too frequently it results in a complete disorganisation of the articulation between the teeth. Still further the superior teeth, even though they may be in a plane anterior to the inferior, do not overlap, the result being that a retention plate must be worn for a prolonged period to keep them in position.

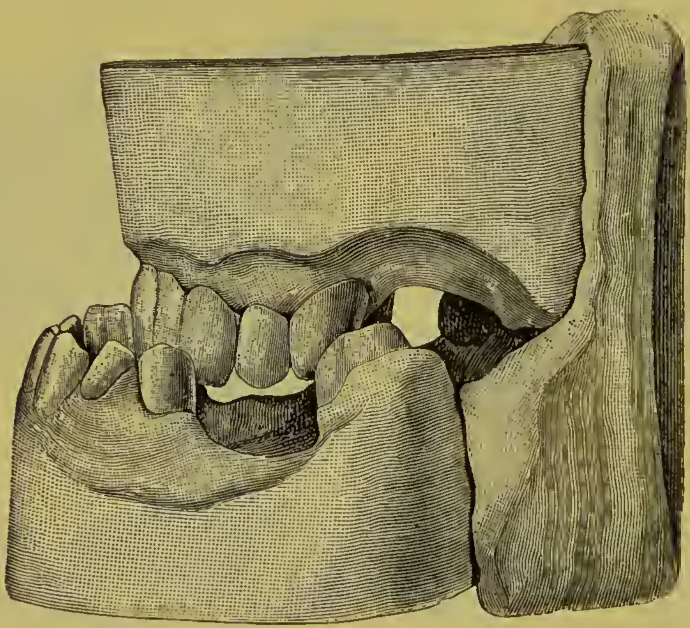


Fig. 273.

In such cases as that shown in fig. 273 the deformity is greatly exaggerated by the loss of the posterior teeth. The insertion of artificial dentures will not only assist in restoring the masticating area, but if the bite is raised will hide the deformity to some extent.

When the protrusion of the mandible is so marked that the upper teeth bite completely within the arch of the lower, something should be done to procure a masticating area. Fig. 274 illustrates a case under the care of Mr. H. G. Read. The protrusion is

excessive. The upper first premolars are completely within the arch of the lower, and although the second premolars and first and second molars are missing, it can easily be seen that they could have been but little use for masticating purposes.

Mr. Read in this case inserted upper and lower dentures. The lower denture was well thickened on the lingual side as shown in fig. 275. This inner thickening occluded with the upper teeth and gave a fairly efficient masticating area.

FIG. 274.

FIG. 275.

In severe types of inferior protrusion similar to those just referred to, it might be possible to improve the condition by surgical means. In the *Dental Cosmos* for July, 1898, Dr. James Whipple reports a case where considerable improvement was obtained by double resection of the mandible.

(*c*) In cases where the fault lies with the maxilla a fair result can be obtained, if the deformity is slight, by expanding the arch of

the upper teeth, and at the same time reducing that of the lower. In cases where the anterior upper teeth are alone involved, a plate should be made to bring them forward into correct occlusion. A case of this character is shown in figs. 276 and 278.

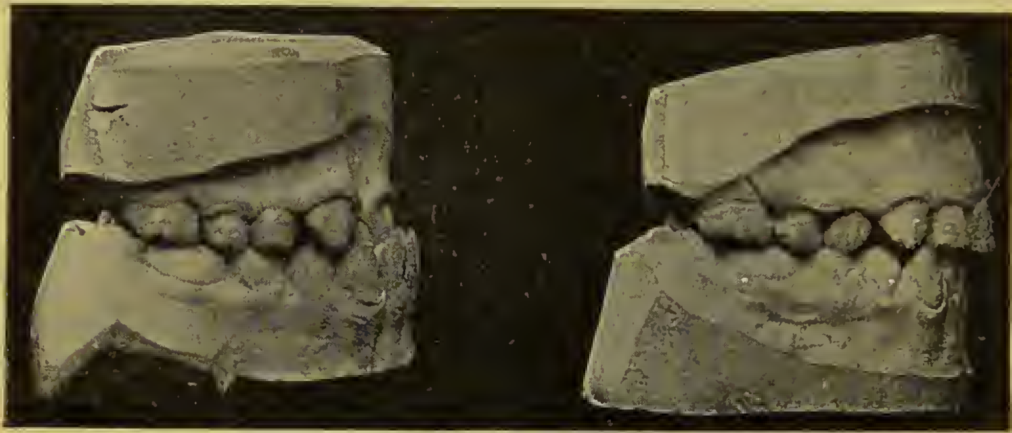


FIG. 276.—Before treatment. FIG. 277.—After treatment.

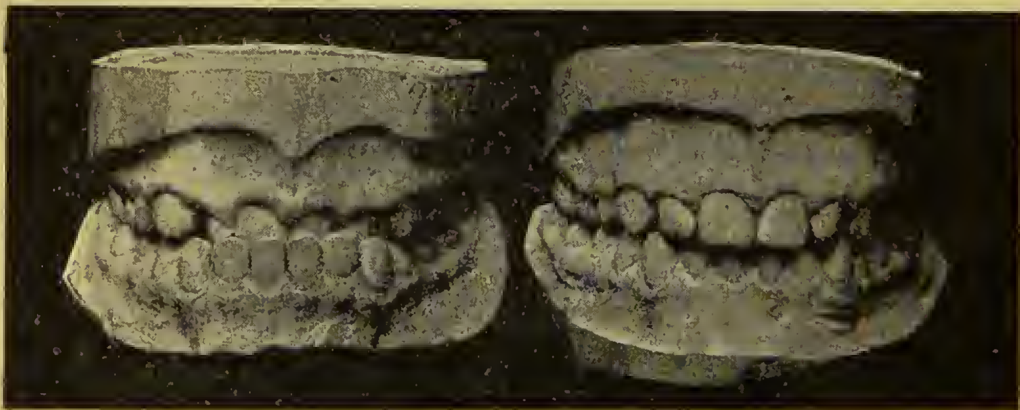


FIG. 278.—Before treatment. FIG. 279.—After treatment.

The patient was under the care of Dr. Case of Chicago, and the treatment consisted of bringing forward the superior incisors by an appliance (fig. 280) based on the principles referred to on p. 88. The result of treatment is seen in figs. 277 and 279.

The models given in fig. 281 show a fair example of a case in which an improvement may be obtained by the treatment being directed to both the upper and lower teeth. The patient was

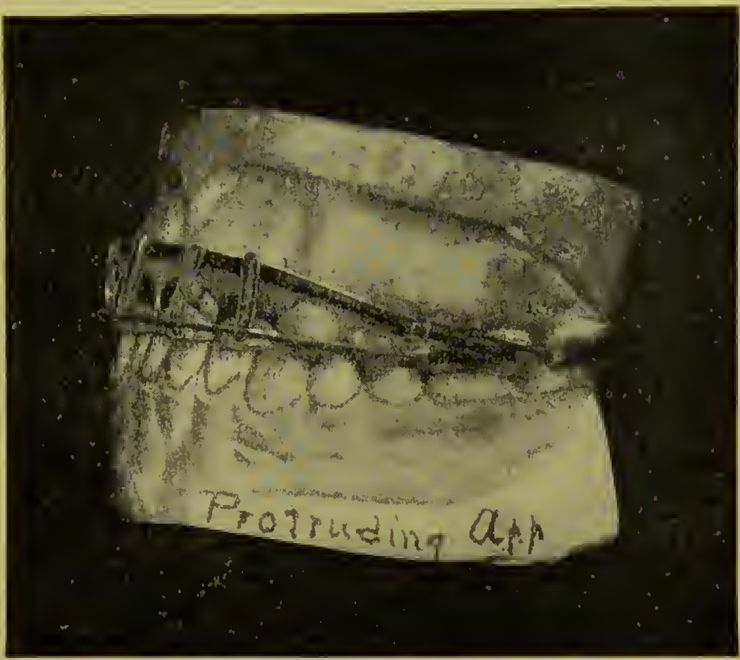


FIG. 280.[1]

FIG. 281.

FIG. 282.

[1] I am indebted to Dr. Case for the use of figs. 276 to 280.

18 years of age when first seen, and had had the left lower premolar removed in addition to the first permanent molars. The arch of the lower teeth was reduced by the extraction of the left central incisor, and that of the upper increased by expansion. The result is shown in fig. 282. There was a distinct improvement in the personal appearance.

The case, the models of which are shown in fig. 283, will help to illustrate one or two points in treatment. The patient was a girl, aged 14. A glance at the figure will show that in complete occlusion there is a good deal of protrusion. In the mandible the first molars have been removed, and in the maxilla the left upper first premolar has been removed to make room for the canine which erupted external to the arch. The superior and inferior premolars fail to occlude, the result being that the whole process of mastication has to be carried on by the molar teeth.

Fig. 283.

On examining the patient it was at once noticed that the mouth was kept slightly open, the lower incisors being brought into contact with the upper. The patient stated that this position was the most comfortable, and that during mastication she constantly suffered from discomfort in the region of the articulation. An examination of the articulation with the teeth in occlusion, as shown in fig. 283, demonstrated that the condyle was brought forward, and was not resting in its normal position in the glenoid cavity. The protrusion was thus to a great extent artificial, and a fair result could therefore be anticipated with proper treatment.

The lines on which treatment in such a case should be carried out are as follows: The anterior superior teeth should be brought

forward so that with the mouth at normal rest they just impinge on the anterior aspects of the lower incisors.

The next stage should consist in "propping open" the bite by artificial means; unless this is done the upper incisors will be driven forward and made to unduly project. The need for a sufficient masticating surface must not be forgotten. The "propping open" of the bite can be carried out by means of a plate covering the lower premolars and molars, or by means of bridges. A skull and chin cap should be worn for some period to counteract any tendency on the part of the patient to return to the old habit of bringing the mandible forward.

(I.) LACK OF OCCLUSION—"OPEN BITE."

This term is applied to that abnormality in which the back teeth alone occlude when the mouth is closed, the remaining teeth being separated by an interval.

From a clinical point of view "open bite" may be considered under three headings:—

(i.) Cases where the premolars and the molars occlude, but the cutting edges of the upper and lower anterior teeth are separated from one another by a space more or less oval in shape.

(ii.) Cases where the majority of the posterior teeth, as well as the anterior teeth, fail to occlude.

(iii.) Cases of partial lack of occlusion in the premolar and molar regions.

(*a*) Etiology.—In cases coming under heading (i.) the deformity is invariably the result of an acquired habit, such as thumb or finger sucking, the thumb or finger being bent and inserted horizontally between the cutting edges of the upper and lower teeth. The pressure thus exerted forces the superior teeth, as well as the alveolar process, in a direction upwards and slightly outwards. In the lower the teeth are forced downwards, but the displacement is not nearly so well marked as in the upper. The artificial teats and similar articles which are given to troublesome children to pacify them are a fruitful cause of this form of "open bite."

In cases coming under heading (ii.) the etiology is frequently obscure. In a few instances the mischief can be traced to the use of regulation plates, the back teeth elongating through being left

uncovered. An example of "open bite" arising in this way is shown in fig. 284. In many cases—more especially the severe ones —the chief cause of trouble lies in some **defective development of the ascending ramus.** Occasionally the deformity can be traced to an obliquity of the ramus, an instance of which is shown in the

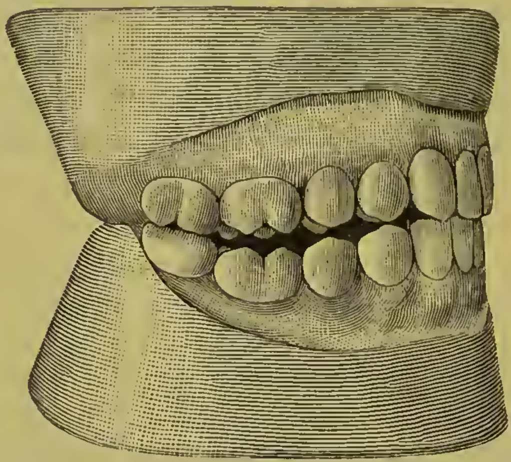


Fig. 284.

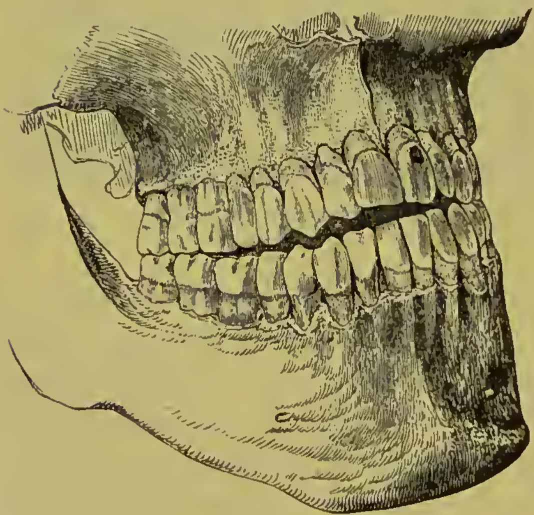


Fig. 285.

accompanying figure from Tomes' "Dental Surgery" (fig. 285). This drawing also serves to illustrate another feature in the anatomy of some examples of "open bite," namely, the increase in the development of the anterior portion of the mandible. In many cases the defective development of the ascending ramus is probably

an actual arrest in growth, known as "shortening," which will necessarily produce an oblique angle.

Another peculiarity which is noticeable in some patients is the somewhat sharp bend downwards of the horizontal ramus at the point where the most anterior fibres of the masseter muscle are inserted. "Open bite" can at times be traced to an arrest in development of the anterior portion of the maxilla, and this condition is also frequently associated with the defective development of the ascending ramus already alluded to. An arrest in development of the superior alveolar process, together with a "honey-combed" condition of the teeth, is often met with in cases of "open bite," the palate being unusually high. Such patients are generally mouth-breathers, and this would lead one to suspect an intimate relationship between mouth-breathing and "open bite."

The bending of the mandible may be explained as follows. The principal force of the muscles at the posterior part of the mandible is upwards, and at the anterior part downwards. The masseter runs as far forward as the point where the facial artery crosses the bone, and it is near this spot that the marked bending occurs. May not this bending be produced by muscular effort? The mouth is kept open of necessity, and the mandible is therefore constantly being acted upon by the depressors of the jaw, while the muscles at the back of the jaw, namely, the temporal, masseter and internal pterygoid, are constantly tending to raise it. It is no new phenomenon to find bones bent in various directions by muscular force, as for example in the case of "rickets," and it seems quite conceivable that the muscles acting under abnormal conditions produce the bending.

With reference to this suggestion, Mr. Tomes[1] thinks that the following is the more probable explanation. "It must be remembered that this bending, and, in fact, all the phenomena of open bite, arise whilst the jaw is growing rapidly, elongating backwards. May it not be that this backward elongation taking place whilst the child is a mouth-breather, and the symphysis pulled down by its depressor muscle, the original growth has taken place in that form rather than that already formed bone has been bent?"

(iii.) Partial lack of occlusion in the premolar and molar region is difficult to account for. In some instances, however, it can

[1] "A System of Dental Surgery," 4th edition, p. 164.

be traced to a local arrest in the development of the jaw, and in a few others to faulty extraction.

(*b*) **Treatment.**—It is impossible to lay down any hard and fast rules for the treatment of "open bite," as each case must of necessity be considered on its own merits.

To deal first with *class* (*i.*), namely, **cases where the deformity is limited to the anterior teeth.** In cases seen at an early age, before the eruption of the permanent teeth, much may be done by breaking the patients of any vicious habits they may have acquired, and with the eruption of the permanent teeth the condition will be to some extent improved. It is well during this period to advise the use of a skull and chin cap. When the habit of thumb sucking, &c., has been continued during the eruption of the second dentition, or when the deformity is severe, treatment is of little avail. But it should be remembered that, although the appearance of the patient is a little unsightly, the premolars and molars articulate, and the teeth can, therefore, perform their function of mastication perfectly well. In these circumstances it is generally best not to interfere, although where the personal appearance is of great importance, the crowning of the upper six anterior teeth might be deemed advisable.

In a very severe case this would hardly be practicable, and it would be better to remove the anterior teeth and insert a continuous gum denture.

The treatment of cases coming under class (ii.) may be considered under the following headings.

(α) Removal of adenoids and enlarged tonsils.

(β) The use of the skull and chin cap.

(γ) The removal of teeth.

(δ) Cutting in the bite.

(ε) A combination of all four.

(α) *Removal of adenoids and enlarged tonsils.*—As nasal obstruction may be, directly or indirectly, one of the causes producing open bite, it is essential that any adenoids and enlarged tonsils should be at once removed, as all such growths are inimical to health.

(β) *The Skull and Chin Cap.*—The skull and chin cap is strongly recommended by some, and in a few cases may perhaps be efficacious in bringing the teeth into proper occlusion—a result which is probably obtained by the posterior teeth being forced into their sockets. Cases treated by this method are recorded by

F. Heuckeroth[1] and Tomes.[2] If this treatment is to succeed the apparatus must be constantly worn, and, in addition, must be properly adapted, care being taken that the elastic bands stretching between the chin and skull caps exert pressure in an upward and not a backward direction. The most suitable cases for this form of treatment are those which are due to some mal-arrangement of the teeth, and not to defective development of the ascending ramus or angle.

(γ) *The Removal of Teeth.*—The extraction of the second molars may be quite sufficient to remedy some examples of open bite, and the case shown in fig. 284 was cured in this way, but, unfortunately, the first molar is generally unsaveable, and under these circumstances the removal of the second molars would not be justified whilst other methods can be resorted to. Under these conditions the treatment most likely to lead to beneficial results is to remove the remains of the first molars and employ the skull and chin cap, and to follow this up by the operation of "cutting in the bite." In examples of open bite which come under notice before the second molars have erupted, the most satisfactory plan seems to be the removal of the first permanent molars as soon as possible, and the use of a skull and chin cap during the eruption of the second molars. When the deformity is very severe it may be necessary to resort to the extraction of a large number of teeth, as in a case recorded by Mr. H. Rose in the *Journal of the British Dental Association* for November, 1896, where the whole of the teeth were removed and dentures substituted with beneficial results.

(δ) *Cutting in the Bite.*—This method is extremely satisfactory, and may be used alone, or in combination with either extraction, or the skull and chin cap. The treatment consists in grinding down the teeth until the premolars and the molars articulate. This operation, which is by no means a new one, might with advantage be more generally adopted. The points in its favour are: (1) it gives the patient a good surface for mastication; (2) it is permanent —teeth forced down by the skull and chin cap tend to rise again as soon as the apparatus is discarded; (3) it relieves the patient of a long and tedious course of treatment.

The operation should extend over several sittings, and a fair

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[1] C. Ash and Sons' *Quarterly Circular*.

[2] "A System of Dental Surgery," 4th edition, p. 161.

Fig. 286.

Fig. 287.

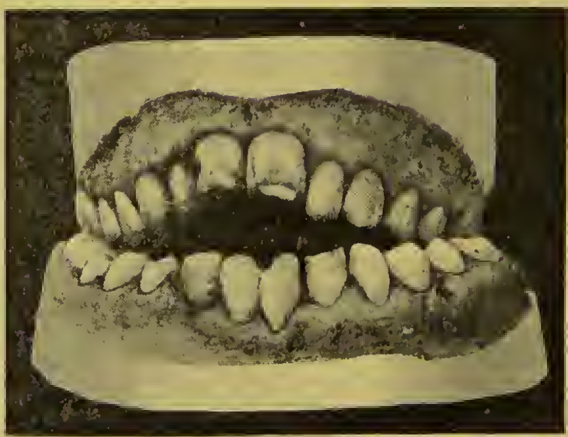

Fig. 288.

Fig. 289.

interval should be allowed to elapse between each. In the case shown in figs. 286 and 287 the treatment was spread over the period of one year. The objects of leaving an interval between each sitting are: (1) any irritability of the pulp caused by the operation has time to subside, and (2) secondary dentine has time to form and so allow a greater portion of tooth structure to be removed. The patients should be directed to apply spirits of wine to the cut surfaces twice a day, and the necessity of first drying the surfaces and of keeping them free from saliva for about a minute after the spirit has been applied should be impressed on them. By this means the cut

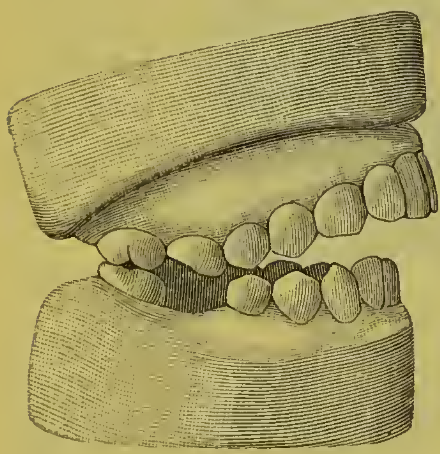

Fig. 290.

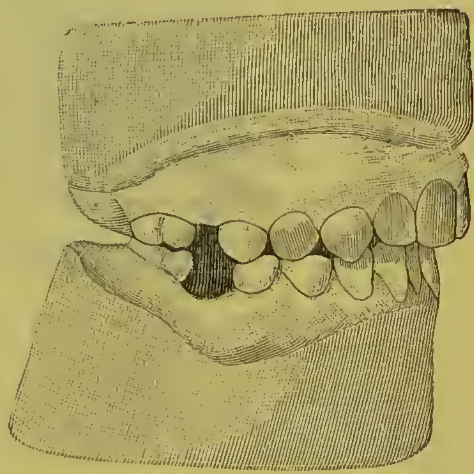

Fig. 291.

surfaces of the dentine are to a certain extent hardened, and any sensitiveness that may exist is allayed. It is also a good plan after each sitting to apply nitrate of silver to the cut surfaces. Another case treated by cutting in the bite is shown in figs. 288 and 289.

(ε) *Combination of Methods.*—In very many cases where a single line of treatment is inadequate to produce a good result, a combination of methods may be successful. This is well shown in the case illustrated in figs. 290 and 291. Here improvement to any great extent can hardly be expected by adopting any one single method, while a combination would be efficacious. In such cases it is useful to pursue the following course:—

(1) To extract the first permanent molars.

(2) To use a skull and chin cap for perhaps six to twelve months, namely, for the period during which the second permanent molars

are moving forward in the gap caused by the removal of the first permanent molars, at the same time expanding the arch if needful.

(3) To "cut in the bite" if the skull and chin cap is not sufficient to bring the jaws together.

Cases coming under class (iii.), namely, "partial open bite," can usually be remedied by mechanical means. The models shown in fig. 292 are from the mouth of a patient under the care of Mr. H. G.

Fig. 292.

Read. There is marked lack of occlusion on the right side. In the maxilla the first molar has been extracted, and apparently there has been a considerable absorption of the bone. The second premolar and second molar have approximated so as to fill the space. In the mandible the second premolar has erupted far back, probably the result of an early removal of the first molar. A carious cavity on the anterior aspect of the second upper molar was filled, while in the mandible a bridge was arranged. By these means an efficient masticating area was created.

CHAPTER V.

Injuries of the Teeth: Concussion, Dislocation, and Fracture.

(A) CONCUSSION.

THIS injury may give rise to slight or severe periodontitis, and may be complicated by pulpitis, which may subsequently lead to death of the pulp. The pulp may be ruptured from its connections at the apical foramen at the time of injury. In these cases the pulp often remains quiescent, but marked discolouration of the tooth substance supervenes.

(1) **Causes.**—Concussion of the teeth may arise from direct or indirect violence. Examples of the former occur from the blow of the fist or from a cricket ball, while a fall, a blow on the chin, jumping upon the heels instead of the toes, will be examples of the latter.

(2) **Signs and symptoms.**—Most patients presenting themselves with this injury will be found suffering from periodontitis more or less severe. In cases where the pulp has not been ruptured at the apical foramen or the inflammation of the periodontal membrane has not extended to the pulp, the tooth will be found sensitive to pressure and will respond to thermal changes in the same way as the normal tooth. Should the inflammation spread to the pulp the tooth will become exquisitely sensitive both to pressure and to slight variations of temperature, the periodontal pain being dull, constant, and restricted to the tooth, while that arising from the inflamed pulp will be of a sharp lancinating character, being referred at times to other teeth and adjacent parts. When suppuration in the pulp occurs the tooth will no longer be sensitive to changes of temperature, but the periodontal inflammation will increase in severity owing to the suppuration having spread to the periosteum. The pain will be of a throbbing character.

(3) **Treatment.**—It is of importance to diagnose whether or not the pulp is implicated, as the treatment is different. The periodontal membrane only being affected, local depletion will be found efficacious; in mild cases counter-irritation, with capsicum plasters, lin. iodi., will be sufficient. When suppuration of the pulp has taken place the pulp chamber must be opened in that position which renders removal of the pulp most easy; the dead pulp must be removed and the canals treated and filled. In cases where concussion has caused pulp irritation, and at the end of two or three days no improvement is apparent, the pulp should be removed, as prolonged endeavours to save the pulp are nearly always followed by periodontitis of an intractable type. The following is an instructive case: a patient, aged 12, falls and fractures a tooth, the right maxillary central, and lacerates the pulp. The left central was implicated by concussion from the blow. The pulp from the right central was removed, and attempts made to save the pulp in the left, which was irritable. The periodontitis around the right tooth rapidly cleared up, but continued with the left tooth. As the pulp condition failed to disappear at the end of three weeks the canal was cleared of the morbid pulp, sterilised and filled. Chronic periodontitis continued in spite of repeated and various treatments for four years, so that removal of both teeth was decided upon. A skiagram of the teeth showed that the root of the tooth originally fractured had been attacked by rarefying periodontitis on the aspect adjacent to the left tooth, and the root of this tooth had to a great extent disappeared from a similar periodontal condition. If the pulps of the teeth had been removed within a few days of the injury the probabilities are that the periodontitis would have passed away and the teeth would have been permanently saved.

(B) DISLOCATION.

(1) **Erupted Teeth.**—By dislocation is understood accidental displacement of a tooth from its normal position in its socket. Dislocation may be partial or complete. In the former the tooth may be forced into or loosened in the socket. In the latter the tooth is totally displaced from its socket.

(*a*) **Causes.**—Dislocation results from causes similar to concussion, but the injury causing dislocation is usually of a more severe nature than that leading to concussion.

(*b*) **Treatment.**—The treatment of this accident **when the dislocation is partial**, is to replace the tooth, mould the broken alveolus around it, and apply counter-irritants to the gum. In all dislocations precautions should be taken to keep the tooth fixed, either by ligatures of silk or wire, or by a small tin splint (see page 96). **If the tooth is driven into the socket**, it should be grasped with a fine-bladed pair of forceps and carefully drawn into place. When, however, a tooth is driven upwards towards the antrum, great care must be taken that it is not displaced into that cavity. Dislocations of this character are often best left alone (see page 592).

If the displacement is complete, the treatment will vary according to the age of the patient and the time at which the case is seen subsequent to the accident. In the young, if seen directly after the accident (as, for example, when the tooth is displaced in the operating room), the tooth should be at once replaced, as under these conditions union of the structures entering at the apex may take place (see Diseases of the Pulp, p. 366). If the patient is an adult, or is seen some hours after the accident, the pulp of the injured tooth must be removed and the canals sterilised and filled before it is replaced.

(2) **Unerupted Teeth.**—The permanent teeth may be injured in their crypts from traumatism, the portion of the tooth already calcified being partially separated from the portion developing. The condition is analogous to forcible separation of the epiphysis from the shaft in a growing bone.

The calcified portion of the tooth is usually dislocated in such a manner that it forms an angle with the developing portion (see figs. 293, 294, 295). In the case of premolars the calcified portion occasionally appears to be forced into the developing part, causing a kind of impacted dislocation (see figs. 296 to 298). It is quite possible that this condition is at times due to careless removal of the deciduous teeth. Dislocation of unerupted teeth is more common in the anterior teeth, since they are more liable to injury. The Museum of the Odontological Society does not contain a single example in a maxillary canine. This tooth escapes from the position it occupies during development.

The injury may occur in the crown or root, the position depending upon the time of the receipt of the injury.

When erupted these teeth often present a marked bulging at the neck, and marked mobility, and it is at times possible to trace the

root through the alveolar wall. Teeth which can be felt high up in the alveolar wall, and which fail to erupt, may be suspected of having been the subjects of this form of injury.

FIG. 293.—From a specimen in the Museum of the Odontological Society.

FIG. 294.—From the Museum of the Odontological Society.

FIG. 295.—Maxillary central.

FIG. 296.—Maxillary first premolar.

FIG. 297.—Mandibular premolar.

FIG. 298.—Mandibular premolar, from specimen in possession of Mr. G. G. Campion.

(C) FRACTURE.

The maxillary front teeth are more frequently fractured than any of the others.

(1) **Causes.**—The causes are generally direct or indirect violence, such as blows from cricket balls, kicks from horses, blows on the chin, &c. Biting upon hard substances in food, such as shot in game, frequently causes this accident in the back teeth, especially when they are weakened by caries.

(2) **Degree of Fracture.**—The fracture varies considerably in degree. There may be :—

(*a*) Slight cracks or fissures involving the enamel only, without loss of substance.

(*b*) Various degrees of chipping of the enamel alone, or enamel and dentine, without exposing the pulp.

(*c*) Transverse fracture involving the pulp chamber (i.) in the crown; (ii.) in the root.

(*d*) Longitudinal fractures.

(*e*) Oblique fractures.

(3) **Treatment.**—**The first group** of cases does not require treatment.

In **the second,** if the fracture involves only enamel it will be necessary to smooth the rough edge or edges with suitable instruments and polish the surface. Should the dentine be exposed it may be found hyper-sensitive, especially in young patients. There will also be hyperæmia of the pulp, characterised by extreme sensitiveness to heat and cold, and pain upon pressure due to the congestion extending to the periodontal membranes around the apex. The treatment is to employ counter-irritants or local depletion, at the same time applying to the exposed dentine local applications, such as absolute alcohol, nitrate of silver, or chloride of zinc. The symptoms usually subside, and at a later period the tooth and its neighbour should be trimmed in such a way that the disfigurement may be as little noticeable as possible. Should suppuration occur in the pulp from continued irritation, the pulp cavity must be opened and treated in the usual way.

Transverse fractures of the crowns of the anterior maxillary teeth, involving the pulp chambers. The treatment will depend upon:—

(*a*) The age of the patient.

(*b*) The sex of the patient.

(*c*) The presence or absence of a crowded condition of the teeth.

(*a*) *Age of the patient.*—The formation of the root of the central incisor should be complete about the age of ten years and of the lateral incisor about ten and a half years. In fracture of the teeth previous to this age, the prospects of retaining them with a view to subsequent crowning are unfavourable. The prospects of success diminish with the youthfulness of the patient. The problem in these cases to be decided is whether it is better to remove the tooth, allow the space to close and disregard the æsthetic question, or consider the latter of more importance, and retain the space and at a future date insert a denture with all its attendant disadvantages to the other teeth. In fractures after the completion of the root,

if the pulp is removed and the canals treated, crowning can be carried out at a future date.

(*b*) *The sex of the patient.*—The loss of an incisor to a boy is of less æsthetic importance than to a girl.

(*c*) *The presence or absence of crowding of the teeth.*—In cases of doubt as to the advisability of saving or removing the fractured tooth, the question of crowding is important. If the teeth are crowded there will be a fair prospect of the space caused by the loss of the tooth completely closing up, while if there is no crowding the chances of the spaces remaining permanent are considerable. Each case must be treated on its own merits. The following illustrative cases may be useful. In **fracture of a maxillary central incisor in a boy** under the age of nine, removal of the tooth is to be recommended. In a boy the æsthetic question does not outweigh the advantages of avoiding a denture.

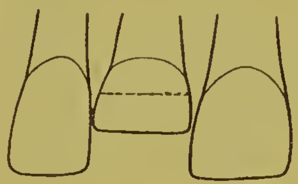

Fig. 299.

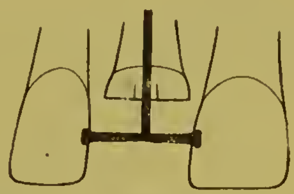

Fig. 300.

Fracture of a maxillary central incisor in a girl under similar conditions. The pulp of the tooth should be removed and the canal packed with loretin or iodoform. If the fracture is in the position shown in the diagram (fig. 299) the neighbouring teeth will not tend to approximate. If the fracture is near the region indicated by the dotted line there will be a tendency for the neighbouring teeth to approximate. Means must therefore be taken to keep them apart by a stay fixed in the pulp chamber of the injured tooth as shown in fig. 300. If periodontitis occurs around the fractured tooth, the tooth should be removed and means taken to prevent the approximation of the adjacent teeth. If a crowded condition of the teeth in the future seems possible, the tooth or space should still be retained and steps taken at once to treat the crowding by removal of the unerupted premolars.

Fracture of lateral incisors in boys or girls under the age of ten should be treated by removal. In the case of the girl, the appear-

ance of the slightest crowding of the teeth on the side should be relieved so as to prevent as far as possible the centre of the mouth shifting (see p. 73).

In fractures occurring subsequent to the period at which the growth of the root is completed, the patient should be anæsthetised, the pulp removed and the canal filled, and at about the eighteenth year the tooth crowned. In cases of fractured upper lateral incisors in crowded mouths the removal of the tooth may be advisable. The decision must be based upon the sex of the patient and the direction of the root of the canine.

FIG. 301.
From a photo-micrograph lent by Mr. F. J. Bennett.

Fractures of the mandibular incisors.—In nearly all cases removal is best. The space, even if it does not completely close, is not very noticeable.

Transverse fracture of the root and oblique fractures, if high up, will be best treated by extraction, but if the fracture does not involve much of the root it can be treated upon the same principles as transverse fracture of the crown. When near the apex of the root the fracture is at times difficult to diagnose. In all suspected

cases a skiagram should be obtained. In fractures running in a longitudinal direction the tooth should be extracted.

Fractures of the posterior teeth occur usually in adults; the treatment resolves itself into one of two courses. If the fracture is transverse and in such a position that the roots are involved, extraction must be resorted to; but in those cases in which the root is uninjured crowning should be carried out.

(4) **Healing of fractured teeth.**—Union of fractured teeth may take place, and a few cases have been recorded. The union is similar to that which takes place in bone. In a case quoted by Wedl, and shown in his "Atlas of Pathology," union is effected by means of the periodontal membrane and the pulp.

A rare example of union of a fractured tooth was recorded by Mr. Storer Bennett.[1] A maxillary incisor had been fractured across the crown. The patient was 17 years of age, and ten months previously had fallen down, struck the tooth and dislocated it upwards, when it became impacted and remained until removed owing to pain. The tooth is shown in fig. 301. The bond of union is of a cavernous character, with numerous spaces for blood vessels.

In longitudinal fractures or separation of the roots in multiple-rooted teeth, where the movement of the fractured parts is slight, the application of a tightly-fitting band around the neck of the tooth may be tried with a view to aid healing.

Fractured roots are more likely to unite when the fracture is near the apex, because the fragments are kept in fairly accurate apposition by the socket of the tooth.

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[1] *Trans. Odonto. Soc.*, vol. xxvii., p. 181.

CHAPTER VI.

The Bacteriology of the Mouth.

By Kenneth W. Goadby, L.R.C.P., M.R.C.S., L.D.S.

The development of bacteriology has exercised an important and far-reaching influence on the science and art of surgery, replacing conjecture by established fact, clearing away erroneous methods and ideas, modifying conceptions of pathological processes, and enabling the surgeon to proceed safely to operative measures for the radical cure of disease where before only palliative treatment was possible. Perhaps one of the most important facts that bacteriology has demonstrated beyond doubt is the necessity for the sterilisation of instruments—a question that applies with undeniable force to the instruments of the dental surgeon. It will be seen subsequently in the present chapter that many pathogenic organisms of various species are at times present in the mouth. Such pathogenic bacteria may be easily transferred from one person to another and inoculated into the gums with a pair of unsterilised forceps. The fact that the organism is present in the mouth of one person without any harm arising does not prevent the organism behaving in a virulent manner in another mouth (*vide infra*). The argument often urged by some, that cases of infection are rare from such causes, therefore it is unnecessary to do more than wash dental forceps, is an ontological obsession.

The use of antiseptic fluids is not sufficient unless the instruments remain in the fluid for a long time, and the simple process of boiling should be substituted whenever possible. Some of the more delicate instruments used by the dental surgeon may be damaged by boiling in water, but the substitution of almond oil for water in a suitable steriliser is all that is required.

The method of dipping the beaks of forceps in pure carbolic acid is unnecessary, the corrosive action tending to depress the vitality

of the parts and to assist rather than prevent the invasion of the bacteria. The preliminary cleansing of the gums with dilute antiseptic, the use of sterile instruments, and the subsequent flushing with antiseptic non-irritant fluids, with perhaps the use of some non-irritant antiseptic powder, seems to be the method likely to give the least chance for bacterial activity, and to be in line with generally adopted methods of surgery.

In the special province of dental surgery—outside questions common to the whole domain of surgery—bacteriology has not yet advanced diagnosis or treatment to any appreciable extent. This laggard position may be attributable to the fact that comparatively few workers have given their attention to the problems of mouth bacteriology, and that no tabulation of results exists to assist the worker in his researches. A thorough review of the subject embracing all the problems concerned in the study of the bacterial flora of the mouth is an extremely difficult matter, owing to the scattered nature of the literature and the insufficient details of description that many of the authors give. It must be remembered, however that much of the present necessity for accurate bacteriological detail is of recent origin and was not understood by the earlier workers—in fact it is only during the last ten years that our increased knowledge of the variability of bacteria of the same species, the alterations in their morphology and chemical activity incident on the chances of environment, have demonstrated how important are seemingly minor details.

The method of separating bacteria into species is based upon the different reactions given upon, or in, the various nutrient culture media, as well as the manner of spore formation, reaction to different staining processes, motility, and a number of other considerations. Some bacteria only differ in some of the lesser details of cultural reactions, and it is therefore of the utmost importance that all the tests possible should be applied. It follows then as a corollary that if the cultural peculiarities of a given bacterium are only partially given it is very difficult, often impossible, for an observer to be sure that the organism he has isolated corresponds to, or differs from, that isolated and described by another.

The bacteriology of the mouth has suffered very much from this looseness of method. It must not be understood that the work of the pioneers of bacteriology is to be slighted, or their many valuable results and deductions lightly passed over; on the contrary

their work gives us direction and impetus, although many of their facts have a different interpretation to-day, and their broad general conclusions remain as the *basis* upon which modern researchers work. Wherever possible the various bacteria from time to time described as true mouth organisms have been included in the present chapter, and to avoid confusion, where biological characters are too indefinite to constitute a well-defined distinction, the organism in question has been omitted. Full reference is, however, given, so that the student will have no difficulty in referring to the paper containing the original descriptions.

The biological characters of well-known pathogenic and non-pathogenic bacteria are also omitted, as well as some other organisms whose identity is not yet fully determined, or which have only been met with occasionally.

Before entering on a general description of the mouth bacteria it is perhaps as well to make a few remarks as to the **nutrient media**, as so much depends on this question. Bacteriologists are now adopting what are termed "standard media," that is, media prepared with definite quantities of the special materials used, and more important still, having a standard reaction, the reaction being expressed in relation to some special indicator. When any new organism is described for the first time particular note should be made of any *special media* particularly advantageous for its growth, the method of preparation and "standard reaction" of which should be clearly stated. The new organism should have its cultural peculiarities on the *usual laboratory culture media* determined, and the definite reaction of such media clearly stated—"faintly alkaline" or "neutral" is not enough. The media I have found answer the best for all general purposes are prepared in the way given by Eyre[1] having a standard alkalinity of plus 10cc. $\frac{N}{1}$ NaOH per litre, with phenolphthaleine as the indicator. For many mouth bacteria a reaction of plus 5 $\frac{N}{1}$ NaOH gives the best results.

Bacteria are more numerous in numbers and species in those mouths that are neglected, where carious teeth are present, and where food is allowed to accumulate around the margins of the teeth. The number of organisms found in gingivitis marginalis and in suppurative periodontitis, or where there are deposits of

[1] *British Med. Journ.*, September 29, 1900.

calculus, is very large. In normal mouths the buccal cavity itself is tenanted by only a few species, the numbers and species being largest on the tonsils and along the gum margin; when, therefore, we attempt a classification of mouth bacteria we must be careful to note the different conditions under which such organisms are found, and to classify the various mouths as "clean" and "dirty"; the latter condition is apparently not always under the control of the individual.

Environment affects the buccal flora: for example, persons who are engaged in the care of infectious diseases may often have those organisms in their mouths which are associated with the particular disease they are tending; workers in bacteriological laboratories often have pathogenic streptococci in their mouths; nurses [1] in hospitals for the treatment of consumption get tubercle bacilli in their mouths. It is not therefore to be wondered at that a large number of organisms associated generally with disease are to be found from time to time in the buccal mucus, existing as **œco-parasites**, as Hueppe[2] calls them; some of the more important ones are briefly reviewed here.

Pathogenic Organisms found in the Mouth.

The pyogenic cocci, Staphylococcus pyogenes aureus, citreus, are occasionally present in the saliva, but, according to the majority of observers, in a somewhat small percentage of cases, and they are by no means always present in all cases of alveolar abscess or in antral suppuration. They are more frequently found in the mouths of persons who neglect their teeth; in healthy mouths they are not often found. Netter[3] only found S. pyogenes aureus in seven out of 127 individuals examined. Vignal[4] and Miller also only found the pyogenic cocci occasionally. On the other hand Black[5] found the S. albus in four out of ten cases examined; the S. aureus in seven. My own researches tend to confirm those of Netter and Miller,[6] the S. aureus occurring in about 10 per cent.

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[1] Osler, "Principles of Medicine," p. 261.
[2] "Principles of Bacteriology," p. 169.
[3] *Revue d'Hygiene*, 1896, No. 6.
[4] *Archiv. des Phys. Norm. et Path.*, 1886, No. 8, p. 342.
[5] *Trans. Ill. St. Dent. Soc.*, 1886.
[6] "Micro-organisms of Human Mouth," p. 264.

of all cases. On looking through the notes on the examinations of a large number of mouths (more than 900) the staphylococcus aureus was only isolated in some 10 per cent. of the cases; no particular search was made for these organisms; in every case the colonies were observed when plating out other bacteria. The colonies in each case, however, were transferred to the usual test media and the organisms properly determined. S. albus is a much more common inhabitant and is present in most dirty mouths, and often in carious dentine, where it probably assists in the process of dental caries. The various strains of S. albus isolated from the *débris* of carious cavities differ in many respects from the normal Staphylococcus albus when first isolated, and in many ways tend to the type of the S. epidermidis albus of Welch [1] in that they liquefy gelatin very slowly, the cocci tend to the diplococcal or monococcal rather than the staphylococcal form, and the coagulation of milk is a much slower process than the coagulation caused by the ordinary S. albus. It is somewhat interesting, in view of this slow liquefaction, to cite the results obtained by Eyre and Galloway,[2] who found that various races of S. albus could be so altered in their behaviour towards gelatin that the rate of liquefaction was reduced by one half by growing the organisms under strictly anäerobic conditions.

A fact that may to some extent explain the infrequent occurrence of the staphylococci in the mouth is the quantitative bactericidal power of saliva demonstrated by Sanarelli.[3] This observer has shown that saliva sterilised by filtration through a Pasteur-Chamberland or other porcelain filter has the power of destroying a certain number of staphylococci. After the saliva was filtered and 10 cc. run into a sterile tube a platinum needle was laid on the surface of a culture (various organisms were used, among the cultures experimented with being staphylococcus aureus) and the saliva inoculated. Plate cultivations were made at intervals, the first being made immediately after inoculation. It was found that the number of colonies gradually diminished, and at the end of twenty-four hours the saliva was free from the staphylococci. If, however, the saliva is inoculated with a whole loopful of the

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[1] *Amer. Journ. Med. Science*, Philadelphia, 1891, p. 439.
[2] International Congress of Dermatology, Paris, 1900.
[3] *Centralbl. für Bakteriol.*, Bd. x., 1891, p. 817.

culture instead of the small quantity which adheres to a platinum needle, then although the colonies diminish somewhat rapidly for about two days, after that time they rapidly increase owing to a development of the organisms in the saliva. The pneumococcus, however, was able to grow from the first. From Sanarelli's experiments we are entitled to think that the saliva has a certain quantitative bactericidal power which, although unable to cope with large quantities of pure cultivations of actively growing organisms, can still act as a deterrent on the isolated bacteria of certain species that from time to time gain access to the mouth, and that it may therefore possess an important function in the prevention of disease. This inhibitive action may also account for the differences in cultural characters that many well-known organisms appear to undergo when resident in the mouth. The fact that it is possible to grow bacteria in boiled saliva does not in any way vitiate Sanarelli's work.

One of the most important pathogenic organisms frequently met with in the mouth is the **Pneumococcus or Diplococcus of pneumonia.** Sternberg,[1] in September, 1880, and Pasteur,[2] in December of the same year, first found this coccus in the saliva. Animals had been injected with saliva for some other reason than the search for the organism of pneumonia, Sternberg using his own saliva, Pasteur that of a case of rabies. Both the animals inoculated by the two independent observers died, and after death the organism now known as the pneumococcus was obtained from the blood in the heart. The organism has since been shown to be the chiefly associated bacterium in croupous pneumonia, and is generally regarded as the exciting cause of the disease. Since Sternberg's original communication many other observers have confirmed the presence of the pneumococcus in the salivary secretions of healthy persons, the organism sometimes being in a highly virulent condition, at other times possessing but a low degree of pathogenic power; for instance, in one case[3] the race of pneumococci obtained from the mouth required passage through the bodies of fifty-three animals (rabbits) before it could be brought to the same standard of virulence that another race, obtained from a case of pneumonia, attained after

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[1] *Nat. Board of Health Bull.* vol. ii., 1882.
[2] *Comp. Rend. Acad. des Sci.*, Paris, xcii., p. 159.
[3] Washbourne and Eyre, *Brit. Med. Journal*, November 4, 1899.

only eight passages. Netter[1] found the pneumococcus present in 15 per cent. of healthy individuals; Wolf,[2] Claxton,[3] Frankel,[4] and many others have also noted its presence in healthy mouths of healthy persons. Vignal[5] found the coccus present in his own saliva for a consecutive period of two months, and Dr. Eyre tells me that for more than two years, during which he has been working at the pneumococcus, fully virulent diplococci have been constantly present in his own mouth. For further information on this interesting organism and its occurrence in the mouth the reader is referred to the original papers and to the text-books for the bacteriological characters, space preventing more than a passing notice here.

The Klebs-Loeffler bacillus is another pathogenic organism frequently met with in the mouths of healthy persons, the organism often possessing a high degree of virulence.

This fact has been pointed out by many observers: thus Aaser[6] found the diphtheria bacillus in 17 out of 895 soldiers in a cavalry regiment. Park and Beebe[7] found that of 330 persons examined at random, 8 had fully virulent and 24 characteristic but non-virulent bacilli in their throats. Meade Bolton,[8] among 214 persons more or less exposed to the disease, found virulent bacillus diphtheriæ in 41·5 per cent., and many more instances might be quoted. It by no means follows that the persons in whose mouths these virulent bacilli are found are suffering from the clinical symptoms of the disease. In a large school during an epidemic of sore throat and diphtheria, of the total number in the school I found 33 per cent. had the diphtheria bacilli in their throats, while only 14 out of the total number of 600 children had clinical symptoms.[9] The importance of these œco-parasites lies in the fact that they may easily be transferred from mouth to mouth, and susceptible persons

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[1] *Compend. Rend. des Sci. de la Soc. Biol.*, 1887, No. 3.
[2] *Wiener. Med. Blätter*, 1887, Nos. 10-14.
[3] *Med. Times*, Phil., 1882, p. 627.
[4] *Zeitsch. für Klin. Med.*, 1885.
[5] *Loc. cit.*
[6] *Deutsch. Med. Woch.*, 1895, p. 357.
[7] *New York Med. Record*, xlvi., 1894.
[8] *Med. and Surg. Reporter*, lxxiv., p. 799.
[9] *Trans. Epidem.*, 1900, p. 99. See also Williams and Fullerton, *Lancet*, 1897, p. 1028.

develop the disease in a severe, perhaps fatal, form. The literature of diphtheria epidemics abounds with such cases, many instances being enumerated where healthy individuals with virulent bacilli in their mouths have been the starting-point from which infection has spread. The late Sir R. Thorne-Thorne in his Milroy Lectures gives several such instances. The possibility of such "bacillusträgende" persons should be constantly in the mind of the dental surgeon, and emphasises the necessity of sterilisation of instruments.

The tubercle bacillus is often to be found in the mouths of persons suffering from pulmonary tuberculosis, and in the ulcers which are at times found on the mucous membrane of the mouth and tongue; the organism is, however, not confined to the mouths of this class only, as it occurs in the mouths of normal individuals.[1] It has been suggested, and not without considerable likelihood, that the common tubercular infection of the cervical glands may be a direct infection from the mouth, the organisms finding their way along some of the lymph channels already in a state of chronic inflammation from septic teeth, more especially deciduous teeth. As is well known, the presence of epithelioma in the mouth is followed rapidly by involvement of the cervical glands, due to the coexisting absorption from the ulcerated surface. Under these circumstances it is easy to understand how ulcerated conditions of the buccal mucous membrane, or carious teeth with dento-alveolar abscesses, can predispose the glands to infection with the tubercle bacilli. The tubercle bacillus is said to be sometimes present in carious dentine.

Primary tubercular disease of the bones of the jaws is uncommon, but occasionally does occur.[2] A case in point recently came under my notice. Two sinuses, leading to the right maxillary antrum, were present, and a considerable portion of the bone was involved in a tubercular osteitis. The case was operated on by Mr. Jacobson, and the infected area thoroughly curetted. Some of the caseous material was inoculated into a guinea-pig, which subsequently died of a general tuberculosis some six weeks after inoculation. At the autopsy a chain of lymphatic glands was found passing upwards from the point of inoculation, the glands all containing tubercle bacilli.

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[1] Osler, "Principles of Medicine," p. 261.
[2] Bernheim, *Dental Cosmos*, 1901, p. 34.

Micrococcus tetragenous, first observed by Gaffky[1] and Koch,[2] in conjunction with the tubercle bacillus in pulmonary phthisis, has often been found in the mouth. Biondi found it three times in 50 cases examined, and Miller states that he has often observed this coccus although he has no figures relating to its occurrence. I have also often found M. tetragenous in dento-alveolar abscesses.

Oidium albicans, the thrush-fungus, is at times present in healthy mouths. The organism occurs in the last stages of wasting diseases, when it constitutes the well-known condition.

Actinomyces, or the Ray fungus, is to be met with, affecting the maxilla or mandible; the typical yellow granules are to be found in the pus.

B. pyocyaneous, another pathogenic organism, may at times be present in normal mouths. I found it present in two out of 580 mouths examined consecutively.

The cultural and other particulars of the foregoing pathogenic organisms will be found in the various text-books of bacteriology, and would be out of place in the present chapter. In passing, however, to the more common mouth inhabitants, the occasional presence of these pathogenic bacteria must be particularly emphasised in their relation to operations in and about the buccal cavities.

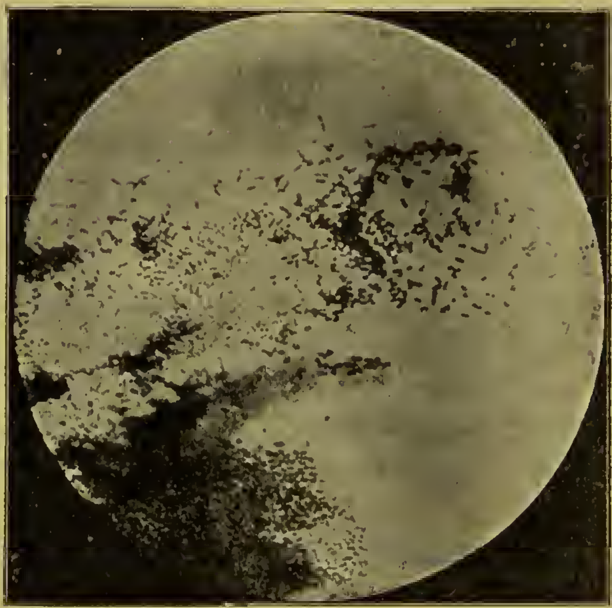
Special Mouth Bacteria.

Passing on to the special mouth bacteria, the species common to all mouths, healthy or unhealthy, clean or dirty, is the **Streptococcus**. It is found not only in the mouth proper, but on the tonsil, pharyngeal wall, nasal cavities, antrum of Highmore, and in the Eustachian tube and middle ear. In these situations it occurs typically in the form of diplococci massed around the dead squamous epithelial cells. Anyone who has made cultures from the mouth cannot fail to have been astonished at the constant occurrence of the streptococcus, and it is by no means confined to the mouth of man, as I have found it in the mouths of monkeys, dogs, rabbits and guinea-pigs.

The diplococcal form of this streptococcus can easily be seen in almost every preparation made from the mouth direct. A cover-

[1] *Von Langenbuch's Archiv. für Chür.*, Bd. xxviii., Heft 3.
[2] *Mitth. auf dem K. Gesundheitsamte*, Bd. ii., p. 42.

glass specimen is made by smearing saliva, scraped from the buccal sulcus with a platinum loop, on to the cover glass. The film is allowed to dry and then stained with carbolic, methylene blue or other stain. The diplococci will readily be recognised massed around and adhering to the squamous epithelial cells (see fig. 302), some of the diplococci having the appearance of short bacilli owing to the elongated and somewhat pear-shaped form of the cocci. The question of the identity of these diplococci with the streptococcus may be proved in



× 1,000.

FIG. 302.[1]—Squamous epithelial cell from mouth surrounded by the diplococcal form of S. brevis.

the following way: clean coverslips are smeared with melted agar to which a little saliva containing some epithelial cells has been added; when dry, the small coverslip-plate is cemented to a hanging drop slide (a slide with a glass ring cemented to it) and fixed in place with a little canada balsam. The preparation is then placed on the stage of the microscope and an epithelial cell sought for with the diplococci attached. The microscope with the preparation *in situ* is then placed in the incubator at 37·5° C. for twenty-four hours. At the end of this time the preparation is examined, when the diplococci will be found to have developed into colonies which surround the cell and in which the streptococcal chains may be

[1] Figs. 302, 303, 306 to 315 are from the *Trans. Odonto. Society*.

easily seen. With a little care one colony can be selected and marked, and cultures on broth and agar made from it as well as coverslip preparations. The culture tubes will show a good growth of streptococci.

This method of obtaining a pure culture of the mouth streptococcus is somewhat tedious, and the method adopted by Dr. Washbourn[1] and myself is much less difficult. Broth cultures are made by adding a loopful of saliva to a tube of nutrient broth; the tube is then incubated for twenty-four hours, at the end of which

× 1,000.

FIG. 303.—Streptococcus brevis; twenty-four hours' broth cultivation.

time the tube will contain an impure culture of streptococci and other organisms. An agar tube is now inoculated from the broth tube and the agar tube incubated. In eighteen to twenty-four hours the sloped surface of the agar tube will be found to be covered with a number of small grey-white colonies, which, transferred to another tube, will give a pure culture of the mouth streptococcus. A little care must be exercised in picking out the colonies, as other organisms are often also present, but there is generally no difficulty in obtaining a pure culture. The explanation of the ease with

[1] *Trans. Odont. Soc.*, June, 1896.

which a culture can be obtained is that the mouth streptococcus grows with great rapidity in almost all media to the exclusion of other organisms.

The streptococcus obtained from various mouths often differ slightly in their cultural characters, but in their general behaviour they conform to the type of von Lingelsheim's[1] Streptococcus brevis, as noted by Dr. Washbourn and myself.[2] Since that paper was published I have obtained the streptococci from 150 consecutive mouths examined; all the cultures obtained conformed to the general characters given below. All of them produced an acid reaction when grown in carbohydrate media (broth to which 2 per cent. of lactose, maltose, glucose, dextrin, cane sugar, or starch had been added). The starch and cane sugar media require the longest to develop the acid reaction, whilst in the other solutions the reaction is often strongly acid in six hours.

The streptococci also clot milk into a solid mass in forty-eight hours.

In the paper quoted above it was noted in connection with the mouth streptococcus that among other characters the few inoculation experiments performed confirmed von Lingelsheim's view that the mouth streptococcus differed from the Streptococcus longus in not being pathogenic for guinea-pigs, rabbits and mice. Other observers are inclined to the view that the streptococcus of the normal mouth is the ordinary pathogenic streptococcus which occurs in pyæmia and phlegmonous erysipelas. Pathogenic streptococci undoubtedly do occasionally occur in the normal mouth, as various observers have shown—a fact that considerably complicates the problem. We have seen that the pneumococcus occurs in normal human saliva in a distinctly pathogenic condition, so much so that a rabbit, an animal particularly susceptible to the pneumococcus, often dies subsequent to an inoculation with saliva, the pneumococcus being found in the blood after death. One of the races of pneumococci obtained from the saliva by Washbourn[3] and Eyre were, however, apparently living in a saprophytic condition, and their virulence was of low value until the organisms had been passed through the bodies of many animals; even then the pathogenicity of the species soon ran down when grown upon artificial media,

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[1] *Zeitschrift für Hygiene*, Bd. x., p. 331.
[2] *Loc. cit.* [3] *Loc. cit.*

whilst other races of pneumococci obtained from the rusty sputum of pneumonia retained their virulence for a considerable time. We have also seen that virulent diphtheria bacilli may be present in normal mouths as well as other pathogenic organisms, and we may certainly also conclude that the streptococci of a pathogenic nature met with in the mouth from time to time are stray individuals of another species accidentally present, and not the common mouth inhabitant. This question of the identity of two presumably different organisms is a much wider question than the particular case of the mouth streptococcus; thus, for instance, B. coli communis and B. typhi abdominalis, B. diphtheriæ and the B. of Hofmann, B. subtilis and B. anthracis, to mention only a few examples, are each related to the other in their cultural peculiarities, method of staining, &c., and somewhat minute differences are relied upon to differentiate the organism from its simulator. It is of course possible that the streptococcus of the mouth is a degenerate non-pathogenic and saprophytic variety of the Streptococcus longus, and that under some favourable conditions it may invade the tissues, as in severe scarlatinal angina, and produce serious results. On the other hand the mouth streptococcus may be a different species, having certain characters in common with the Streptococcus longus it is true, but differing from it in others, among which is its virulence. Lingelsheim[1] was the first to point out that the streptococcus obtained from the normal mouth differed from the Streptococcus longus. Thus it was not pathogenic for rabbits or mice, it rendered broth uniformly turbid, and the chains on this medium were shorter than those of the Streptococcus longus and it caused a slight liquefaction of gelatin, and Lingelsheim therefore considered it a distinct species and named it the Streptococcus brevis, from the short chains formed on broth cultures. Marmoreck, in opposition to this, looks upon all streptococci as simple varieties of the same species, which can all be raised to a uniform type by appropriate means, although various strains of streptococci obtained from different pathological conditions of the human subject behave differently when injected into animals.

In the paper already quoted[2] the following conclusions are given:—"The streptococcus occurring in the normal mouth agrees with the S. brevis of Lingelsheim, and can be distinguished from the

[1] *Loc. cit.* [2] *Loc. cit.*, p. 199.

streptococcus of disease by its biological and morphological characters. It must be looked upon as a distinct species for the present, although ultimately this view may prove to be incorrect, for it is possible that further researches may enable us to convert the streptococcus brevis into the streptococcus longus. This, however, has not hitherto been accomplished. We think that the discrepancies of different observers who have investigated the question are partly due to the fact that the pathogenic streptococcus longus is sometimes accidentally present and has been mistaken for the normal streptococcus of the mouth."

Subsequent research tends to confirm these conclusions, and for the present the S. brevis of the mouth is to be regarded as a distinct species and as the most constant of all mouth organisms. In perfectly clean and healthy mouths it is often the only organism met with.

Various other pathogenic organisms have been stated to be present in the normal mouth. Biondi[1] particularly gives a list of five organisms of this class, which requires notice. Of the five organisms in Biondi's list two were only met with once, in each case by inoculating an animal with saliva, the organism being found in the resulting abscess. These two organisms then (**Coccus salivarius septicus** and **Staphylococcus salivarius pyogenes**) can hardly be called true mouth bacteria.

The third on Biondi's list (**Streptococcus septo-pyæmicus**) is said to be indistinguishable from the streptococcus of pyæmia and erysipelas in its cultural peculiarities and its pathogenic action on animals, and there seems no reason to doubt that this streptococcus was the S. pyogenes which we have seen is at times present in the mouth.

The fourth organism described by Biondi is the **Micrococcus tetragenous** cited above, whilst **B. salivarius septicus** has since been shown to be the same as the Diplococcus pneumoniæ, already mentioned.

Miller[2] in the course of his investigations isolated four mouth organisms which gave pathogenic results when injected into animals. In a later publication[3] the same observer mentions the

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[1] *Zeitschrift für Hygiene*, Bd. ii., 1887, p. 194.
[2] *Loc. cit.*, p. 265.
[3] *Dental Cosmos*, July, 1894.

pathogenic effect of injecting into animals portions of septic pulps, or cultures of bacteria obtained from such pulps; unfortunately the biological characters of the organisms used is not given. The four organisms described as occurring in the mouth are one coccus and three bacilli, and were only obtained a limited number of times. The biological descriptions, as given by Miller, are appended.

Micrococcus gingivæ pyogenes.—Obtained by Miller from a case of suppurative periodontitis three times at intervals of three months, and once in a very dirty mouth.

Morphology.—Irregular cocci or plump rods, occurring solitary or in pairs.

Biological characters.—An äerobic, facultative anäerobic, non-liquefying micrococcus. Grows well at the room temperature and in the usual culture media.

Gelatin plates.—Forms spherical, well-defined colonies, with a sharp margin, which at first are colourless under the microscope, but later become opaque.

Gelatin stab.—A well-marked growth occurs along the line of puncture and a copious raised growth on the surface. No liquefaction occurs.

Agar streak.—A thick, greyish, moist growth occurs in twenty-four hours, which has a purple tinge by transmitted light.

Sugar media (composition not stated).—A considerable development of gas occurs and a strongly acid reaction is soon present.

Pathogenesis.—Subcutaneous injections into mice were followed by local abscess and necrosis, and sometimes by the death of the animal. Intraperitoneal injection invariably produced death in twelve to twenty-four hours.

[Staining reactions and growth on milk, potato, broth, &c., not given. This organism is probably nearly related to B. coli communis.]

Bacillus gingivæ pyogenes.—Found by Miller with the organism mentioned above and in a suppurating tooth pulp.

Morphology.—Short and thick bacilli, with rounded ends, one to four times as long as broad, occur singly or in pairs.

Biological characters.—An äerobic, facultative anäerobic, liquefying bacillus. Spore formation, staining reactions and motility not mentioned. Grows rapidly in the usual culture media.

Gelatin plates.—In twenty-four hours the colonies appear as round, yellowish areas, with sharp, dark border when viewed under the microscope. The gelatin is seen to be liquefied around them. In forty-eight hours the colonies have become confluent and the plate entirely liquefied.

Gelatin stab.—Liquefaction occurs rapidly and in the form of a funnel, the liquefied fluid containing a deposit of white flocculi.

Agar streak.—A thick, moist layer is formed along the track of the needle, which, under the microscope, has a slightly yellow tinge and a fibrillated structure.

No other biological characters given.

Pathogenesis.—Pathogenic for mice, rabbits and guinea-pigs when injected subcutaneously in comparatively small doses (0·25 cc. of a broth culture). At the autopsy peritonitis, sometimes purulent, is observed. Death occurs in ten to twenty-four hours. The bacilli are found in the blood in small numbers. Subcutaneous injection of animals produced a local abscess only.

Bacillus dentalis viridans.—Found by Miller in the superficial layers of carious dentine.

Morphology.—Slightly curved bacilli with pointed ends, solitary or in pairs.

Biological characters.—An äerobic, facultative anäerobic, non-liquefying bacillus. Spore formation, motility, staining reactions not given.

Grows well in the usual culture media.

Gelatin plates.—Spherical colonies with concentric rings, almost colourless except under the microscope, when they are slightly yellow. The gelatin is coloured a faint green.

Gelatin stab.—A limited growth occurs along the track of the needle and a considerable growth upon the surface. No liquefaction occurs.

Agar streak.—A thin growth with an irregular margin occurs along the track of the needle. The growth is bluish by transmitted light and greenish-grey by reflected light.

No other cultural characters given.

Pathogenesis.—Injections into the peritoneal cavity of mice and guinea-pigs usually cause fatal peritonitis in from one to six days; the bacilli are found in the blood in small numbers. Subcutaneous inoculation into animals produced severe local suppuration.

Bacillus pulpæ pyogenes.—Obtained by Miller from a gangrenous tooth pulp.

Morphology.—Bacilli slightly curved and pointed, occurring in chains, in pairs, or solitary.

Biological characters.—An äerobic, facultative anäerobic, liquefying bacillus. Spore formation, motility, staining reactions not given.

Gelatin plates.—Large, darkish, yellow-brown colonies appear, which in eighteen hours produce liquefaction, and soon liquefy the whole of the gelatin.

Gelatin stab.—Liquefaction begins within forty-eight hours and gradually extends, the liquefied gelatin being separated from the non-liquefied portion by a horizontal plane.

No other biological characters given.

Pathogenesis.—Injections of 0·05 cc. into the peritoneal cavity produced death of white mice in eighteen to thirty hours.

Suppuration in and about the jaws is of common occurrence, nevertheless the bacteriology is at present in a very unsatisfactory condition. Cultivations made from dento-alveolar abscesses by no means always give a growth of either of the common pyogenic cocci.

Arkövy[1] has recently published the results of a series of experiments with an organism called by him **B. gangrænæ pulpæ**, which he has found in a large number of the cases of chronic dento-alveolar abscess, in septic pulps and in carious dentine. This organism is pathogenic for mice and guinea pigs; less so for rabbits.

Biondi, whose work has already been referred to, found the Micrococcus tetragenous in a considerable number of the cases examined.

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[1] *Viertlejahrschriff für Zahnheilkunde*, xiv. Jahrgang, Heft iii.

Miller[1] has shown that the inoculation of gangrenous pulps under the skin of animals is almost invariably followed by the symptoms of severe suppuration, often resulting in the death of the animal. In some of the cases the pyogenic cocci were obtained. It is moreover a commonplace clinical fact that if the contents of a septic pulp be accidentally forced through the apical foramen of a tooth, suppuration is likely to follow.

Kirk[2] has recently pointed out that in some cases of dento-alveolar abscess connected with living pulps a pathogenic culture of an organism allied to the diplococcus pneumoniæ can be obtained.

From what has gone before it will be at once seen that as such pathogenic bacteria as virulent streptococci are at times present in the mouth we should expect, occasionally at any rate, severe affections, such as pyæmia and infective endocarditis, would arise from suppuration about the jaws. The literature of the subject is entirely in accord with such a surmise, and it is rare for a year to pass without one or two cases of the former occurring. One case[3] in particular may be mentioned. A boy was taken with severe symptoms of septicæmia and cerebral disturbance after the extraction of a tooth. The case was treated with antistreptococcus serum and made a rapid recovery.

Arkövy[4] and Dobrzyniecki,[5] working under him, have found the **B. gangrænæ pulpæ** in a large percentage of their cases of both septic pulps and chronic abscesses, and as the paper is somewhat a classic one, the biological characters of the organism are appended. For a full and detailed account of the experiments and the effect of antiseptics on the development of the organism, the reader is referred to the original paper. The abstract in the *Cent. für Bakter.* is not quite complete. So far I regret I have been unable to obtain a culture of the organism Arkövy describes, and I am inclined to think the occurrence of this organism has been somewhat overstated.

The following are the characters of the B. gangrænæ pulpæ as given by Arkövy :—

Morphology.—Pleomorphic bacilli with a tendency to the formation of streptococci (? streptobacilli) on certain media. On gelatin it forms straight bacilli

[1] *Dental Cosmos, July*, 1894.
[2] *Dental Cosmos*, November, 1900.
[3] Washbourn, *Trans. Odont.*, June, 1896, p. 265.
[4] *Loc. cit.*
[5] *Centralblat. für Bak.*, No. 23, p. 623, 1897.

of about 4 μ in length, which lie end to end in chains (streptobacilli) Two bacilli may be united at an acute angle; on agar the coccus form predominates.

Biological characters.—An äerobic, facultative anäerobic, motile, pleomorphic, liquefying, chromogenic bacillus. Forms spores.

Gelatin plates.—At the end of twenty-four hours minute white colonies resembling flour-dust make their appearance. These gradually become yellow in colour, and in about thirty hours have become confluent, the plate liquefied with a whitish wrinkled pellicle forming over the surface. An extremely unpleasant smell is given off, resembling that of old cheese.

Gelatin stab.—At the end of twenty-four hours liquefaction commences, and the liquefied area soon reaches the side of the tube. Flocculi form in the liquefied gelatin, and in ten to twelve days a wrinkled pellicle is formed on the surface. The gelatin is coloured a red-brown, the pellicle being a dirty brown. The liquefied gelatin gives a strongly alkaline reaction.

Agar plates.—At the end of twenty-four or thirty hours small white colonies make their appearance. They have a flour-dust-like form, similar to the gelatin plates. Occasionally the colonies are larger, flat and leaf-like, and marked with fine striæ. The same unpleasant smell noticed on the gelatin plates is also present.

Agar streak.—A wrinkled layer, five to six millimetres broad, is formed, which becomes brown after five or six days. The medium itself is also coloured a brownish tint.

According to Rader's international colour-scale the tints produced by the organism in question on the different media are as follows:—

(1) Agar—colour of growth on surface ... ... 33 brown—a
(2) Gelatin—reflected light ... ... 33 brown—d
,, —transmitted light ... ... cinnabar—3a

Blood serum.—A brown, liquefied streak is produced along the track of the needle.

Broth.—Forms a well-marked pellicle, the colour being the same as that of the gelatin cultivation.

Potato.—Moist, brownish, wrinkled skin forms over the surface.

Milk.—Precipitation of casein occurs.

Pathogenesis.—Subcutaneous inoculation in mice produced diarrhœa and death in twelve days. The bacilli are found in the blood. The bacillus is also pathogenic for rabbits and guinea-pigs when injected subcutaneously in large doses.

Ulcerative stomatitis, aphthous stomatitis and gangrenous stomatitis, are as yet *sub judice* as far as their bacteriology goes, and the same applies to several other pathological conditions of the buccal mucous membrane. Ulcerative stomatitis often occurs in epidemics, and it has been suggested that the cause is the same as that of foot-and-mouth disease [1] of cattle, and that the infection is spread by the milk from infected cows. Oidium albicans, or Saccharomyces albicans, to use the modern term, has already been

[1] Osler, "Principles of Medicine," p. 442.

referred to in passing. It belongs to the order of yeast fungi, and consists of branching filaments which develop the characteristic cells.

The bacteriology of suppurative periodontitis is still in an unsatisfactory condition, and a large number of bacteria have been described as the cause at various times. Some observers, among them Newland-Pedley[1] and Bland-Sutton,[2] incline to the view that the condition is one that depends upon a constitutional condition of osteo-arthritis.

Miller,[3] whose great energy has also carried him into this field of research, examined thirty-nine cases of suppurative periodontitis in man and six in dogs, but the experiments were mostly negative. One fact of considerable importance was brought out, namely, the small incidence of the pyogenic cocci, Staphylococcus aureus occurring but once. These cultures were made on gelatin ; in no instance did all the same organisms occur in each case. Another series of cultivations was made, agar being used instead of gelatin. Twenty cases were examined, and twenty different bacteria were isolated, Staphylococcus aureus occurring but twice. Three of the organisms produced a severe effect when injected subcutaneously into animals. No one organism was found common to each case, and Miller was unable to determine any one organism as the "specific" cause of suppurative periodontitis.

Galippe[4] and Malassez cultivated an organism which, on subcutaneous inoculation into animals, produced intermuscular and joint abscesses. Galippe also came to the conclusion that the disease was capable of transference from person to person. Direct inoculation of the gingival margin with the organism produced no particular effect, as was the case with the organisms experimented with by Miller.

Somewhat later Whittles[5] stated that he had discovered the specific organism of suppurative periodontitis, but the only description given was that it was probably anäerobic.

Quite recently Cook[6] has published a communication on the subject. He adopts the views of Loeb, that the various inorganic

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[1] *Dental Record*, May, 1897.
[2] *Ibid.*
[3] "Micro-organisms of the Human Mouth," p. 328.
[4] *Übersetzung von Manassewitsch*, 1888.
[5] *Anat. Anzeig.*, 1899.
[6] *Dental Cosmos*, November, 1900.

salts which are to be found in protoplasm do not enter into combination as a whole but as their ions. The question of immunity or predisposition to disease is supposed by Loeb to be bound up with these ion-proteid compounds, and that substitution of one for another proteid-ion produces susceptibility to a given disease. Cook endeavours to show that the alteration of the Mg.-ion in the saliva may influence the vital activity of the bacteria, and that the pathogenicity of the organism thus affected may undergo a change. At the same time a change in the ion-proteids of the body, produce a greater tendency to disease, and the organisms present are thus enabled to invade the tissues. The theory is an enticing one, but unfortunately rests on conjecture, whilst it does not harmonise at present with known facts, and the argument brought forward that the administration of iodides has a beneficial effect in suppurative periodontitis is open to other interpretation.

It is probable that the chemical construction of the molecule has some bearing on the question of predisposition to disease, more especially as the effect of micro-organisms on bodies of determinate chemical structure is often of a selective nature. Thus Pasteur showed that certain organisms, when grown in a solution of racemic-acid composed of the lævo- and dextro-rotary tartaric acids, produced a change in the previously optically inactive solution and caused it to become lævo-rotary. The organism had used up the dextro-rotary acid, leaving the lævo-rotary untouched. It has also been shown from the researches of Le Bell and van't Hoff[1] that the probable construction of the proteid molecule is an asymmetric one, and that therefore it may be suggested that as these different asymmetric compounds (sterioisomers) are assimilated by micro-organisms selectively and combined with its protoplasm, the particular isomer so attached depends both on the already existing asymmetric arrangement of the protoplasmic molecule and the special asymmetry of the attached isomer; immunity, therefore, may be associated with determinate molecular structure, and predisposition to disease may in some way depend on the ease with which an organism can remove a portion of the proteid molecule to form toxines and other bodies.

In the course of his paper Cook mentions a thread-forming organism which he has isolated, and to which he is inclined to

[1] "Arrangement of Atoms in Space," p. 12.

attribute some prominent *rôle* in the production of suppurative periodontitis. The organism in question, as far as can be gathered from the somewhat scanty particulars given, seems to correspond with the Cladothrix buccalis, which was published in the *Trans. Odonto. Soc.* in June, 1899. Cook, at the end of his paper, seems to have had doubts as to the specific nature of the organism he mentions, as he says, very truly, that " the bacteriological study of this disease is not complete, there are a number of organisms requiring to be studied more fully."

Miller was the first to endeavour to make a **classification of the bacteria of the mouth**, and tabulates them thus:—

Leptothrix inominata, Leptothrix buccalis maxima.

Bacillus buccalis maximus.

Spirillum sputigenum, Spirochæte dentium.

Jodococcus vaginatus.

To this list may be added the *Leptothrix racemosa* of Vicentini,[1] the *Streptococcus brevis* of Lingelsheim, and the *Cladothrix buccalis* provisionally (*vide infra*). All these organisms, with the exception of the Streptococcus and perhaps the Cladothrix, have one common characteristic—they refuse to grow in the usual culture media when cultures are made from the mouth direct. Up to the present only a few of these bacteria have been obtained in pure culture, but before long it is to be hoped that the whole of them will be isolated and worked out.

The **Jodococcus vaginalis** of Miller is probably several distinct forms which are allied morphologically. It gives the iodine reaction, as do certain other of the mouth bacteria. The form described by Miller consists of chains of cocci enclosed in a sheath.

Leptothrix racemosa of Vicentini was at first credited by its discoverer as the origin of all bacteria found in the sputa and saliva, morphological form alone being relied upon. Subsequently his view has been modified, but he still considers that many of the morphological forms met with in the mouth are phase forms of this peculiar organism. The organism in question may be found in the majority of mouths, but more plentifully in those mouths where little or no care and attention is bestowed upon the teeth. It may form thick, whitish deposits upon the surfaces of teeth not opposed

[1] " Cryptogamic Flora of the Mouth " ; also *Dental Cosmos*, 1900, April, &c.

to one another, and may at times form a thick creamy layer along the gum margin, where it is intermingled with other species of organisms, many of which have been confused with it.

In the ordinary method of making coverslip preparations from the mouth the characteristic form of the organism is very apt to be destroyed and the "heads" broken up. Vicentini and Williams,[1] who have worked at this organism, have adopted glycerine as a mountant (fig. 305), by which method the various forms are more easily preserved intact. Another method which has not

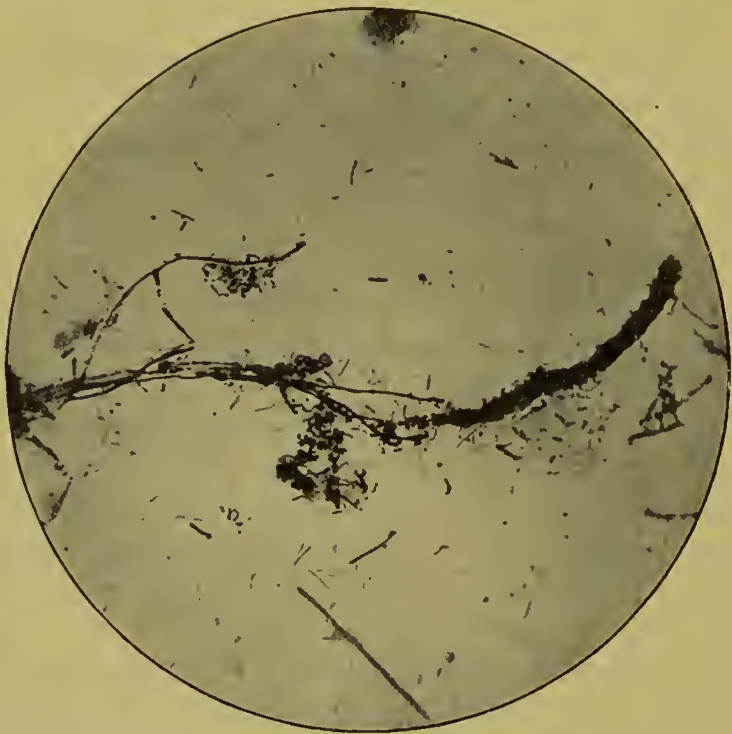

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FIG. 304.--Leptothrix racemosa of Vicentini, from mouth direct. Balsam mount. Photomicrograph and specimen by Dr. Leon Williams.

been adopted by either of the observers mentioned, and which gives excellent results, is to examine the organism in the hanging drop, saliva or 0·75 per cent. salt solution being used as the medium. Such preparations are of course not permanent.

The organism, according to Vicentini and Leon Williams, belongs to a higher order than the Bacteria or Schizomycetes, and it is suggested that it should be placed among the Fungi. Williams thinks that the process of sporulation that he has seen is nearly allied to the Uridineæ or Rusts. In coverslip preparations, and

[1] *Dental Cosmos*, April, 1899.

particularly in the hanging drop made from the white deposit containing this organism, curious felted masses of entwined threads are seen, many of which appear as if surrounded with closely adhering cocci. Some of these masses are finger-shaped and project from the general mass of the threads and cocci (see fig. 305). After a little search isolated specimens can be found, when the cocci-like bodies are seen to be arranged in regular order and, according to Williams and Vicentini, attached to the thread by basidia which, according to the former, are seen to pass from the thread to the "spore." The

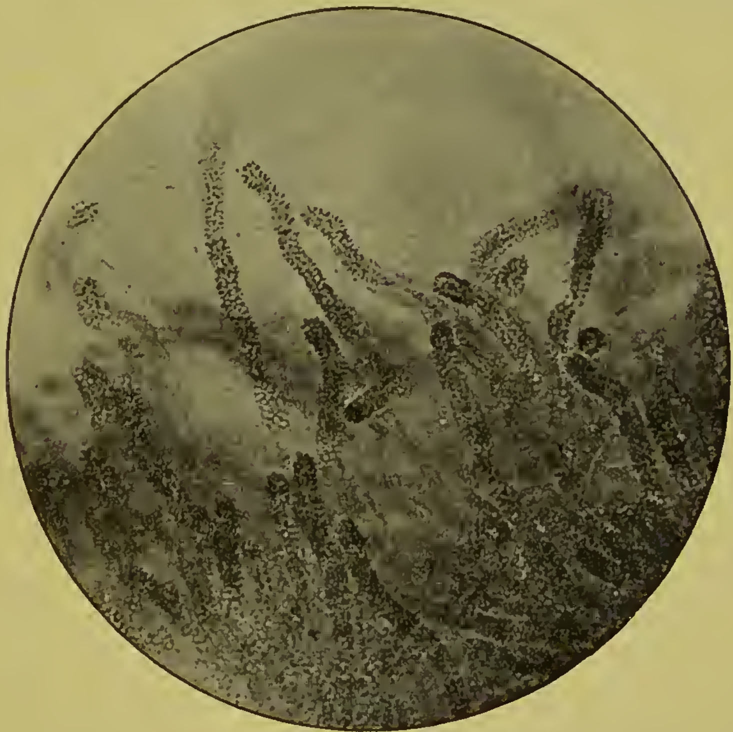

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FIG. 305.—Leptothrix racemosa of Vicentini, from mouth direct, showing "fruitful heads." Glycerine mount. Photomicrograph and specimen by Dr. Leon Williams.

central thread can easily be traced through the mass of spore-like bodies to its free end, the whole appearance reminding one of the common "Friar's Cowl" of the hedge-rows when ripe. Williams gives a number of photographs of this organism, some of which show the cocci-like bodies particularly well, but it is by no means certain that these basidia are not artifact. If the "spores" are attached with these basidia or short stalk-like processes of the central thread, one would expect to observe the basidia on free spores, or on parts of the thread, which so far has not been accomplished. If, on the other hand, the spores are attached one

to another they are more referable to the type of some of the moulds (*cf.* Penicillium).

The threads of this peculiar organism have been shown by Williams to stain in a special way with a modification of the Gram method, as follows:—the material containing the threads, &c., is carefully made into an emulsion with distilled water and then stained with hot aniline gentian violet for from eight to ten minutes. The specimen is then placed in hot iodine solution to fix, washed in absolute alcohol and then counterstained with methylene blue; by this method of staining, spore-like bodies are seen to occupy the ends of the segments of the threads. The spore-like areas may be stained in another way, which rather precludes their description as spores. A coverslip preparation is made and MacConkey's capsule stain[1] poured on. The preparation is then warmed until steam commences to be given off (it must not be allowed to boil), the stain is left on the coverslip for five minutes, washed off and the coverslip mounted. The curious beaded appearance of the threads is brought out by this method; the stained "spores" are more to be regarded as arthrospores rather than true endogenous spores. On staining with Miller's iodine or with iodine acidulated with sulphuric acid, some of the areas apparently corresponding to the areas that stain with the foregoing method take a faint blue or violet tinge—in other words, they give the granulose reaction.

Good specimens of this organism are difficult to obtain, and great care must be exercised in making the coverslip preparation. The best method to adopt is to suspend some of the material containing the organism in distilled water. A large drop is transferred to a coverslip and allowed to dry—anything like spreading should be avoided. Flaming the coverslip is also liable to break up the organism, and it is best to fix with alcohol and ether as in staining blood-films.

When Vicentini first sent the description of the organism to Miller the latter was of the opinion that it should be classified as a Cladothrix or Crenothrix rather than a Leptothrix, but upon the representation of Vicentini he withdrew his objection. Williams, while accepting the term Leptothrix provisionally, has shown that the "fruitful heads" may be not inaptly compared to the fructifica-

[1] Dahlia, ·5 gm., methyl green (00 crystals), 1·5 gm., sat. alcoholic fuchsin, 10 cc., water to 200 cc.

tion of the Cordiceps militarius and Botritis Bassini,[1] providing the sterigmata and basidia exist. At the same time the method of sporulation or fructification of the Cladothrix and Crenothrix have some points in common with the organism under discussion.

The gonidia or asexual spores of Botritis Bassini are supported upon well-marked sterigmata or basidia, the term basidium being used in both a general sense when it is applied to the end of the thread that undergoes asexual sporulation, and in a special sense, when it is used to indicate the stalk upon which the asexual spore or gonidium is carried and by which it is attached to the parent thread.

In Penicillium the carpophore or special spore-bearing hypha is an erect branch of the mycelium, the terminal portion of which divides into numerous branchlets which in turn divide up into a chain of naked gonidia without special sterigmata, a condition with a little modification that is not unlike the sporulation of the L. racemosa.

Again, the Crenothrix breaks up into a multitude of spore-like bodies, the terminal portion of the thread undergoing multipartate division into gonidia; these may be extruded or remain attached to the interior of the thread. It is also to be noted that if a freely growing coccus, such as Staphylococcus albus, be grown in the presence of an equally freely growing bacillus, coverslip preparations made from the mixed culture will shows cocci apparently attached to the thread forms and to the shorter bacilli as well, much in the same way as the preparation from the mouth shows cocci attached threads supposed to be the early sporulation of the L. racemosa. It is, moreover, not difficult to produce the appearance of sterigmata by using a stain like gentian violet, which is notorious for its quick deposit.

There are many other points of similarity between the L. racemosa and some of the Ascomycetes, for further particulars of which the reader is referred to Du Bary's book.

As the organism we have been discussing has as yet defied attempts at cultivation, it is difficult to assign it to any particular genus. Its morphology does not so far conform with any one class of Ascomycetes or Schizomycetes.

Zoph[2] gives as the definition of the genus Leptothrix :—rod-

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[1] Du Bary, "Morphology of Fungi," p. 65.

[2] *Die Spaltpilze.*

shaped and spiral forms, which grow out into straight, wavy or filamentous forms. These may show a difference between base and apex. Cocci-like reproductive bodies are formed by segmentation of the rod-shaped elements in the filaments.

The L. racemosa corresponds sufficiently to this general description to allow the provisional acceptance of the term, but if the sterigmata are really present and not artifact, the organism belongs to a much higher species and must be referred to the Ascomycetes. If such should prove to be the case by subsequent research it is not improbable that it will be found that the so-called leptothrix observed in the mouth is a phase form in the life history of some organism living outside the body in another form.

It may be as well to remind the reader that the suggestion that L. racemosa is the parent form of all the organisms to be found in the saliva is not in accord with fact. Some of the thread forms described by Miller may be, however, portions of the threads.

Leptothrix buccalis maxima and Leptothrix innominata (Miller) may conveniently be discussed together. In the first place the only difference between the two forms is one of iodine reaction (granulose), and very slight morphological differences; moreover, it is extremely likely the L. racemosa was figured as one or other of these thread-forming bacteria. The genus Leptothrix, to which these thread forms have been referred, is a somewhat ill-defined one, as will be seen from the definition given by Zoph. Many observers have talked of various species of leptothrix from the one fact that the organism noted formed threads. This thread-forming habit is a common one among bacteria, as for instance, B. anthracis, B. subtilis, Spirillum choleræ and many others, the streptococcus even at times forming a chain of rod-shaped bodies of the streptobacillus type; to call an organism a leptothrix therefore because of its thread form is, to say the least, loose nomenclature.

The formation of threads depends on such general conditions as reaction of medium, temperature, moisture, oxygen, &c., and though the genus Leptothrix is somewhat vague, it is sufficiently definite to prevent the inclusion in it of simple forms of bacilli. We have seen that in a leptothrix the two ends should show differentiation, that its mode of reproduction is not the binary fission of the Schizomycetes nor yet endogenous spore formation, but is more allied to the gonidia formation of the Hypomycetes or Moulds.

There are, therefore, two points to apply as a test in distin-

guishing a leptothrix : (*a*) differentiation of the ends of the thread; (*b*) method of sporulation. Referred to such a criterion the two organisms of Miller can hardly be denoted Leptothrix, nor does the organism described by Vignal[1] and Robin come under this classification.

In the present chapter, therefore, although the term Leptothrix innominata and Leptothrix buccalis maxima are retained provisionally to avoid confusion, it is on the understanding that they may be ultimately proved to belong to some other entirely different genus.

× 1,000.

FIG. 306.—Coverslip preparation, mouth direct, showing thread forms. B. max., &c.

"The Leptothrix of Tooth Decay" is a mythical organism, and the sooner it is abolished from our nomenclature the better.

The Leptothrix innominata of Miller occurs in all mouths where a white deposit is found along the gum margin. The morphological form consists of long threads, sometimes curved, 0·5 μ to 0·8 μ in diameter, commonly massed into bundles which are mixed up with

[1] Loc. cit.; also Steinberg's "Bacteriology."

cocci and other organisms. With acidulated iodine no granulose reaction is given.

The Bacillus maximus buccalis of Miller is another organism that is often present, especially in dirty mouths, and is the largest of the organisms of the mouth. The Leptothrix buccalis maxima of Miller only differs from the Baccillus maximus in two points—that the threads do not give the iodine reaction, and that they have segments of greater length. As these differences are too slight to differentiate the two organisms, and it is more than probable that the two are one and the same form, the following description refers to both.

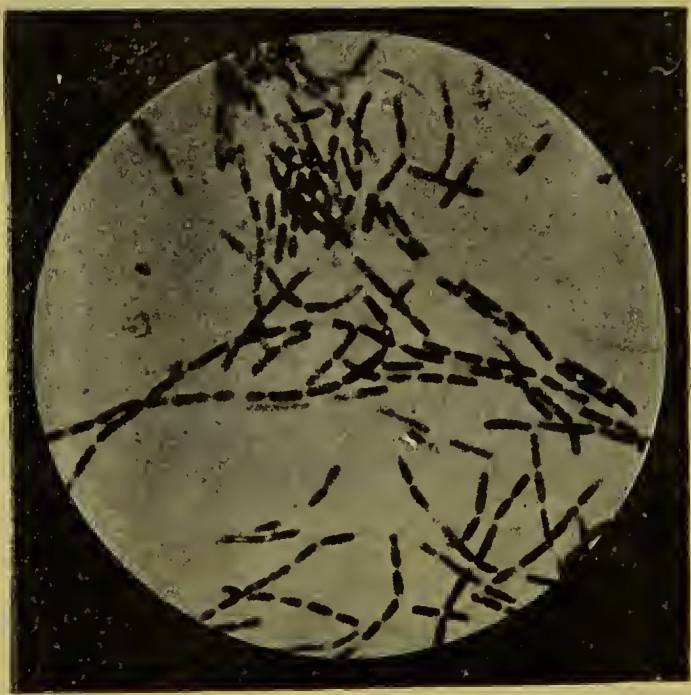

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FIG. 307.—B. maximus buccalis, twenty-four hours' agar cultivation. Stained Gram.

During an extended investigation of the organisms of the mouth, I have constantly met with the large-jointed forms of the B. maximus, and after considerable trouble succeeded in isolating them for the first time.[1] The first culture was obtained by plating agar cultures

[1] *Trans. Odont.*, June, 1898, p. 180.

which had been obtained by streaking broth cultures on to agar slants. A large number of slants from a single broth tube were made, and those tubes were selected which showed the organism sought for in fairly large numbers, and a second slant made from this or from a subsequent tube, the organism was plated out. A somewhat less tedious method is that described for the culture of the Spirillum sputugenum (*vide infra*), but whichever method is adopted considerable trouble is experienced in obtaining a pure culture, the bacillus seeming to require some time before it grows freely in artificial culture media.

The B. maximus obtained in pure culture corresponds closely with the morphological form described by Miller with the exception of the iodine reaction, which is only given by a few of the oldest threads. The organism is not pleomorphic, it forms spores and has no differentiation of its extremities. Upon the ordinary laboratory media the bacillus grows out into long articulated threads, which in old cultivations are often twisted and contorted. In these old cultures involution forms make their appearance, and alteration and shrinkage of the cell plasm occur, giving an appearance of vacuoles, the cytoplasm staining irregularly with methylene blue, and red granules are to be seen in it.

The organism is motile, and forms endogenous spores which resist a temperature of 75° C. for half an hour.

Robin, and later Vignal, have described certain species of leptothrix which, from the particulars given appear, to be bacilli. Vignal's[1] organism has the same general characters as the one just described, but differs from it in certain important respects.

The following are the characters of the **Bacillus maximus buccalis.**

Found in the mouth, particularly in dirty mouths along the gum margin, not infrequently upon the tonsil.

Morphology.—Thick jointed threads, 0·1 to 1·5 μ broad, 10 to 20 μ long; some threads may be much longer, others twisted, especially on old potato cultures. The individual elements are 1 to 4 μ long, but may be much longer. It stains with the ordinary aniline dyes and by Gram's method. With carbol methylene blue, red granules often appear. In old cultures the threads stain irregularly, especially with c.m.b.; some of the unstained spaces seem to be vacuoles, others are highly refractile spores which stain a deep red by Möller's method.

A twenty-four hours' culture on broth is motile, the shorter segments having a twisting irregular motion; some of the long threads are also motile.

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[1] Loc. cit.

The flagella are stained by Pittfield or with night-blue. There are generally six lateral and two terminal, and only isolated flagella at intervals on the threads.

The bacilli do not stain with iodine and acid as a rule, but at times they take a faint blue colour. In old cultures the rods appear granular, and many oval, large, and irregular involution forms appear.

Biological Characters.—Äerobic, facultative anäerobic, liquefying, motile, sporing bacillus.

Gelatin plates.—At the end of twelve hours white, grey, flat, round colonies, with a slightly darker centre when viewed by transmitted light. *Microscopically.*—Irregular dentated edges slightly yellow, with dark brown, irregular centre, with feathery edge overlying the lighter part, which is fibrillated.

Gelatin stab.—Cone-shaped liquefaction in twelve hours.

Gelatin streak.—Twenty-four hours, deep groove of liquefaction in centre with flocculi in the fluid.

Agar plates. — Twelve hours, brownish, round, raised colonies similar to gelatin plate.

Agar streak.—Twelve hours, brownish grey streak, with irregularly-defined edge. With a pocket lens the surface is distinctly granular, having the appearance of frosted glass, thick and easily scraped up with the spatula. The bacilli grow out into long articulated threads.

Broth.—Twelve hours, granular precipitate with masses floating in the fluid, no pellicle and little turbidity. A pellicle may be formed at the end of three or four days. Motility well marked but not excessively so.

Litmus milk.—Well-marked acid reaction, no clot.

Blood serum.—Twelve hours, raised, moist grey growth, no liquefaction.

Potato.—Twelve hours, thick, well-marked raised growth, later the surface turns a dirty grey.

Glucose broth, lactose broth, well-marked acid reaction in two days' time, no gas given off. Grows well on glucose formate media (anäerobic), but not so well as äerobically; no gas formed.

Spore formation well marked. The spores resist a temperature of 70° to 75° C. for half an hour.

No gas bubbles appear on gelatin shakes, and no indol or nitrites are formed in broth or peptone water cultures.

Pathogenesis not determined.

Spirillum sputugenum and Spirochæte dentium.—A good deal of interest is attached to the occurrence in the mouth of "vibrios," and at one time the comma-shaped bacilli of the mouth were supposed to be identical with the Cholera spirillum. Miller[1] in 1883 mentioned that he had observed comma bacilli in the mouth. Lewis[2] in 1884 called attention to the bacilli as resembling the Cholera bacillus by its staining reactions, its form and size.

The researches of Miller, although carried on for two or three

[1] *Trans. Botan. Soc.*, 1883, p. 224.
[2] *Lancet*, September, 1884.

years and with a very large selection of culture media, did not result in the cultivation of these spirilla. In the course of the researches, however, two or three varieties of spirilla-like forms were isolated. Two in particular are discussed; one of them, obtained but once, was thought to be closely allied to the Finkler-Prior vibrio, and judging from the details given there seems little doubt that such was the fact. The other spirillum[1] is a non-motile organism which forms curious contorted and twisted shapes, and grows on the usual culture media. Some of the rods are so much twisted that the appearance of a capital O is produced. In old cultures cocci-like bodies are formed which take a streptococcal form. The non-motility of this species, as well as its cultural characters, differ from the mouth spirillum as well as the cholera vibrio.

The spirilla occurring in the mouth are therefore by no means all of one variety, although in all dirty mouths and in a limited number of clean mouths comma forms are to be met with as well as the fine spirochæte.

In inflammation of the gum margins and suppurative periodontitis these comma and spiral forms appear to predominate. The fact can be easily verified by making a coverslip preparation from the mouth of a person with gingivitis marginalis and staining with dilute aniline gentian violet, clearing first in absolute alcohol. The gentian violet appears to be the best stain to use, as the spirilla, in common with the majority of the same class, take all stains somewhat slowly. The preparation may require to be cleared with alcohol after staining, as the background is often a good deal stained. The slide made in this way will generally show three forms, namely, short comma-shaped bacilli, spirilla and spirochæte, the latter with what are probably arthrospores attached to the threads, and corresponding to the same bodies seen in the cholera vibrio.

If, instead of making a coverslip preparation, some of the original material is examined in the hanging drop on a suitable slide, comma-shaped bacilli will be seen which are extremely motile, darting about in all directions; the spirilla are also motile, whilst the spirochæte are only slightly so in comparison, their motion being confined to quiet revolution upon their long axis with little forward motion. The comma-shaped bacilli are bions derived from fission

[1] *Indep. Pract.*, 1885, p. 227.

× 1,000.

FIG. 308.—Comma-shaped bacilli, mouth direct.

× 1,000.

FIG. 309.—Spirilla forms, mouth direct.

of the spirilla. For a long time these interesting vibrios resisted all attempts at isolation and pure culture. Miller, who with praiseworthy energy made thousands of cultivations, only obtained the spirilla in impure culture, and even then they died out in a short time and no pure culture was obtained. For a long time the same result attended my own efforts, the organisms appearing for a time on many species of fluid media, but disappearing on attempts at pure culture. After two years of experiment a pure culture was at last obtained, and subsequently from eleven other cases spirilla were isolated in pure culture, all the cultivations corresponding in their reactions on the various test media (figs. 310 and 311). The method adopted at first was discarded for a later medium, alkaline potato[1] gelatin, upon which the spirilla can be obtained only, however, after a good deal of trouble. The colonies at first are minute and not much larger than a pin's point, and require some time before they become acclimatised to their new surroundings; transference to three and often five or six different tubes may be necessary before sufficient growth is obtained to plate with any chance of success.

When cultivated for some time on artificial media, spirochæte-like forms with attached arthrospores are formed similar to the forms seen in the mouth (see fig. 311).

The organism thus isolated, a full account of which is published elsewhere, differs from the Cholera spirillum, Vibrio Finkler-Prior and Vibrio Metschnikoff in many points, although in others it bears a resemblance. A well marked cholera-red reaction is produced on the addition of pure (nitrite free) sulphuric acid to a six-days-old broth, or peptone water culture, as suggested by Durham. The rapid sleeve-like liquefaction of gelatin stab cultures that is so marked in V. Finkler-Prior is not given by the mouth spirillum which does not liquefy the gelatin so quickly as V. cholera. Slight liquefaction of blood serum occurs, similar to the effect produced by the other vibrios, but by no means as marked as Finkler-Prior. Milk is clotted, and a considerable quantity of acid is formed as with V. cholera and V. Metschnikoff.

The growth on potato occurs at the room temperature, V. cholera and Metschnikoff only producing the colour in the hot incubator.

Intraperitoneal injection of the agar cultures twenty-four hours

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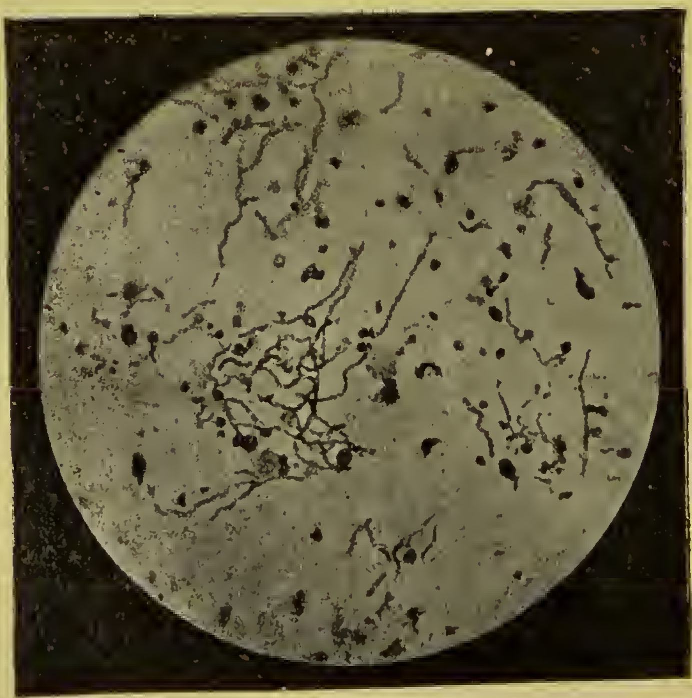
[1] *Trans. Odont.*, 1898.

x 1,000.

FIG. 310.- Spirillum sputugenum, twenty-four hours' agar cultivation. Comma forms.



x 1,000.

FIG. 311.- Spirillum sputugenum, four weeks' agar cultivation, showing involution forms.

old produced death in from three to five days in guinea-pigs. The bacilli were not present in the blood, but were obtained in large numbers from the peritoneal cavity.

Spirillum sputugenum.—Found in the mouth along the gum margins, in the cavities of carious teeth and on the tonsil. It has also been occasionally found in the pus from suppurating antra.

Morphology.—Vibrio, occurring in young cultures as comma-shaped rods 0·1 to 0·3 μ in breadth, 1 to 2·5 μ long, with rounded or pointed ends. In older cultures growing out into well marked spirilla, some composed of commas united in series, others of spirilla with four or five turns without a break. Very long threads are also met with; these are often much thinner (spirochæta); the spiral forms are most common after forty-eight hours and best marked on broth.

In old cultures swollen and twisted involution forms are seen; some of these are at the ends of the spirilla and commas, and present a similar appearance to the form seen in the mouth itself. Curious spherical bodies are at times to be seen in the course of the threads similar to the arthrospores described by Hueppe in the cholera vibrio; spherical bodies are also to be seen with no attached spirilla.

No endogenous spores have been seen. The organism stains with great difficulty, best with carbol-fuchsin or carbol-spillers purple or with aniline gentian violet after treatment with alcohol. It is not stained by Gram's method. In old cultivations the threads and spirilla stain unequally, and give the appearance of chains of bacilli with unstained intervals.

A twenty-four hours' broth culture is extremely motile. Upon staining by Pittfield's method or with night-blue a single terminal flagellum is to be seen.

Biological characters.—An äerobic, facultative anäerobic, motile, liquefying spirillum. Does not form spores.

Gelatin plates.—At the end of forty-eight hours, minute greyish-white colonies much like streptococci appear. They are moist and flat, and the gelatin around them soon commences to liquefy.

Microscopically (1 in.) brownish, round or slightly oval colonies, not granular, and with a darker, irregular, opaque central area.

Gelatin stabs.—Cup-shaped liquefaction in four days, little fluid; the tube may be often inverted without the liquefied mass running out, white flocculi in liquid and at bottom.

Streak.—Groove of liquefaction in three days with white flocculi. No pigment is produced on this or any other gelatin culture.

Agar plates.—Good growth in twenty-four hours, brownish, flat, raised, smooth, defined edge.

Agar streak.—Good growth in twenty-four hours, with well-defined straight edge, grey and translucent. The older cultures become a buff colour.

Blood serum.—Twenty-four hours, brownish streak with slight liquefaction which progresses very slowly.

Litmus milk.—Twenty-four hours, well marked acid reaction with clot in five to seven days.

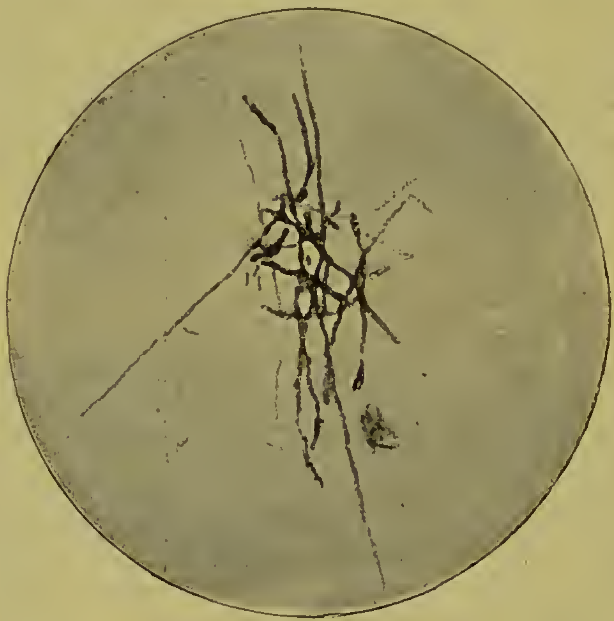
Broth.—Twenty-four hours, general turbidity and trace of pellicle. Seventy-two hours, well marked pellicle. A four days' culture gives a well marked cholera-red reaction with pure (nitrite free) sulphuric acid.

Potato.—No apparent growth in twenty-four hours at 37° C.; two to three days at 20° C. well marked rich red-brown colouration, moist and shiny. Involution forms and threads often appear.

Glucose broth—Lactose broth.—Well marked acid production in forty-eight hours. Gas given off. Grows well on glucose formate media without oxygen, and produces gas on glucose formate broth.

Pathogenic for guinea-pigs (four only inoculated); 1cc. of agar culture emulsion fatal in three to five days when injected into the peritoneal cavity.

So far all the organisms mentioned as obtained from the mouth belong to the Schizomycetes, with the exception of the doubtful species L. racemosa. Various members of the *Blastomycetes*, to



× 1,000.

FIG. 312.—Cladothrix buccalis, mouth direct. Stained Gram, showing clubs.

which the yeast fungi belong, may often be found in the mouth, their presence often depending upon the work and food of the individual. For instance, yeasts are commonly present in the mouths of bakers and millers, and also in the mouths of persons recovering from various diseases, such as enteric fever, dysentery, when the restriction to a pure milk or farinaceous diet is no doubt the explanation. Some of the Blastomycetes have recently been shown to possess pathogenic properties, and to be associated with some forms of new growth (granuloma), but within the limits of the present chapter it is impossible to enter into the matter.

The moulds are also commonly met with in the mouth, and Aspergillus niger is not an infrequent mouth inhabitant.

One other organism of common occurrence deserves notice, partly on account of its relation to one of the pathogenic species, and partly as it belongs to the class of sewage fungi. This is the Cladothrix, a species only recently found as a mouth organism.

The *Cladothricæ* are a class of thread-forming bacteria which hold an intermediate position between the moulds on the one hand and the bacteria on the other. The Ray-fungus Actinomyces is nearly related to the Cladothricæ, and what is even more interesting, the suggestion has latterly gained ground that both the Diphtheria bacillus and the Tubercle bacillus are a stage in the life history of one of these species of Cladothrix or Streptothrix.[1]

The presence, then, of a member of this group in the mouth as a normal inhabitant is important.

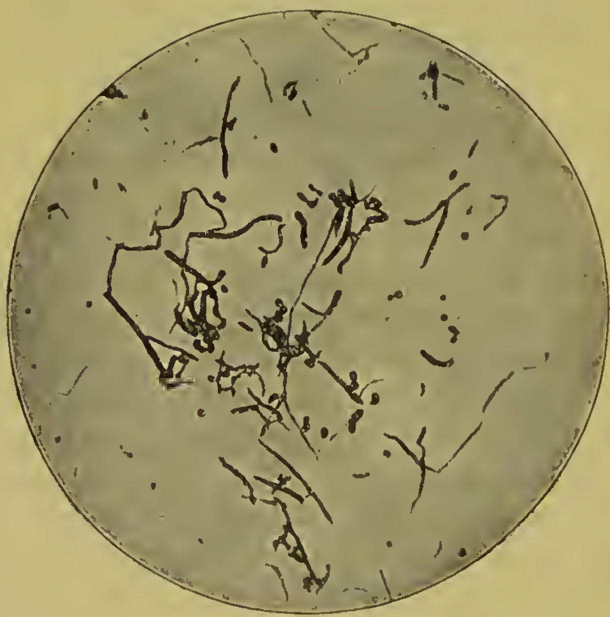
The Cladothricæ are a group of fungi of pleomorphic habit, producing a branched mycelium-like network of threads, the ends of which become differentiated into forms that closely resemble various bacteria (*vide* fig. 314). The members of the species are fairly well distributed and exist, among other curious places, upon the feet of the ordinary house-fly. If one of these insects is allowed to walk over a gelatin plate colonies of Cladothrix dichotoma generally make their appearance.

The *Cladothrix buccalis* is often present in the bacterial deposit that is to be found attached to the interstitial margins of teeth, and is also to be found in the *débris* from the superficial layers of carious dentine. The organism stains by Gram's method, the clubbed ends of the branches taking the stain deeply. The filaments are truly branched, and do not appear to have the false branching described in the Cladothrix dichotoma of Cohn. Old cultures on most media, but typically on boiled potato, break up into a remarkable mass of what appear to be cocci, bacilli, spirilla and every other morphological form of bacteria (see fig. 314). The colonies on agar are very characteristic, and are hard and leather like, refusing to be removed from the medium unless scraped off entire ; they are still more difficult to break up on the coverslip. As a rule, the colonies do not appear until the second or third day after the culture tube is inoculated, and the characteristic form of small

[1] *See* Hueppe, *loc. cit.*, pp. 198, 199.

× 1,000.

FIG. 313.—Cladothrix buccalis. Twenty-four hours' agar cultivation. Stained Gram.



× 1,000.

FIG. 314.—Cladothrix buccalis. Seven days' potato culture. Stained Gram.

cones pointed and, later, with a white tip do not appear for several days. I have cultivated this cladothrix side by side with Cladothrix dichotoma, C. Nivea and four other varieties of Cladothrix, and so far it differs in every respect from those experimented with. Vicentini in his researches, and also Williams, came across this curious organism, but passed it over with a few remarks. After my description was published Leon Williams called my attention to the fact that he had found the organism and gave me a subculture of the specimen he had obtained. This culture agreed in all respects with the organism that I have described. Vicentini did not isolate the organism he observed, but there is no doubt that it is the same. The organism referred to by Cook is also evidently the same as has been stated above.

Cladothrix buccalis.—Found in the mouth attached to the teeth and in carious dentine.

Morphology.—Rod-shaped, filamentous forms which show distinct branching, the ends of the branches are often clubbed; the older threads also have a tendency to form long, articulated, streptobacilli-like forms on fluid media. On solid media the filamentous branching forms are best seen in from forty-eight to seventy-two hours. The involution forms appear in four to five days, and are best seen on potato cultures, where all the various morphological forms of bacteria are simulated. The white crests of the colonies are found to be masses of spores (gonidia).

Staining reactions.—Stains by Gram's method and by the ordinary aniline dyes, the older threads taking the stain irregularly, the clubbed ends taking the stain most deeply.

Biological characters.—An ärobic, facultative anärobic, liquefying, pleomorphic cladothrix. Does not form true endogenous spores.

Gelatin plates.—At the end of forty-eight hours minute, hard, raised, colourless spherical colonies appear, which increase rapidly in size, and form raised cone-shaped projecting colonies, the tops of which become coated with white, dusty material consisting of the spores. The summit occasionally becomes split across when the appearance is most characteristic. Sometimes the colonies do not project so much from the surface of the medium, and remain as flat, circular areas which gradually become white and sink into the gelatin—liquefaction commencing about the fifth to eighth day.

Gelatin stab.—Slight development occurs along the line of puncture, and liquefaction of the medium commences about the fifth day. The liquefied gelatin is separated from the non-liquefied by a horizontal plane.

Gelatin shake.—No gas bubbles are produced, the colonies form a faint cloud which is thickest at the surface, and liquefaction proceeds from above.

Agar.—At the end of forty-eight hours, small, hard, raised, transparent or slightly cloudy colonies about the size of a pin's head. Three days, raised truncated cones, whitish brown, and in the older colonies a crack appears across the top of the cone.

The colonies eventually form slight depressions in the agar; they are

extremely difficult to remove with the platinum needle, and must be removed entire with some of the medium.

Blood serum.—No discolouration of medium, slight liquefaction occurs, spirilla forms well marked, which stain by Gram.

Litmus milk.—Forty-eight hours, no change in colour, later colour reduced and precipitation of casein with thick floating scum. Morphologically mostly streptobacilli.

Potato.—Yellowish or orange-brown colouration in form of hard, flat layer, the top of the slice of potato where there is less moisture soon becomes covered with round, chalk-white colonies about the size of small shot. Pleomorphism well marked.

Broth.—Curious flaky patches form around the meniscus after three or four days, and gradually form gelatinous masses which fall to the bottom of the tube. The scum that adheres to the side of the tube is often a chalk-white colour.

Spore formation.—Emulsions of eight-day-old cultures suspended in broth and heated to 75° C. for half an hour gave no subsequent growth. No spores (endogenous) were seen in the hanging drop or stained by the usual methods. No motility observed.

Sulphur grains not seen in the threads.

From this brief survey it will be seen that a number of different bacteria are to be found in the mouth, some of them species of wide distribution, others belonging to what are called special mouth bacteria. Some of these organisms are pathogenic and especial note has been made of such, but it must be noted that a large number of other species, not generally classed as pathogenic organisms, are often living a semi-parasitic life in the normal mouth, some of these species having an ætiological relation to the question of dental caries. We have also seen that the capability of existing in the saliva is not common to all bacteria alike, and that changes in environment and other conditions react upon bacteria in a way that is different for various species. We have also seen that food changes and environment have a direct bearing on the species and perhaps the number of organisms in the mouth. The mouths of new-born infants do not contain bacteria, just as the intestine of a newly-born child is free from micro-organisms—all bacteria that are present are therefore adventitious ; some species finding the environment suited to their development remain and flourish, others soon perish or are crowded out by the other species.

The Bacteriology of Caries.

The researches of Miller, Williams, and myself have shown that the active agents in the production of dental caries are bacteria,

and it has therefore been assumed by some that such a fact is enough to account for the phenomenon of caries.

In discussing the bacteriology of dental caries we have the, at first sight, paradoxical fact that in some mouths apparently "clean" and "healthy" caries is rampant, while in other mouths uncared for and by no means clean caries hardly exists. Now although caries is a process (not a specific entity) nearly allied to putrefaction, it takes place in the mouth, a cavity in the body bathed with the saliva containing living cells and subject to various vital changes that may go on in the individual; we must, therefore, approach the study of its ætiology by the methods applied to the subject of disease in general, although caries is not exactly referable to the category of true disease. Calling to mind therefore the various general predisposing factors which contribute to the initiation of any disease by the dynamical liberation of pathological energy through the activity of micro-organisms, we find that though the liberating cause may be present, yet the chain of health is stronger, even in its weakest links, than the liberating energy of the particular organism. Thus, for example, we have seen that fully virulent diphtheria bacilli may be present in the throats of a number of individuals, yet only in a very small number of the whole does the organism institute those series of pathological changes the manifestation of which we know as the clinical symptoms of the disease. Nor is diphtheria an isolated example of the œco-parasitism of a pathogenic organism. A little reflection will show that the ætiology of dental caries is a special case of such a phenomenon, for in some mouths although bacteria are present in vast numbers caries does not occur, and in others with a less luxuriant flora caries is present in a high degree. Now the teeth themselves are scarcely capable of bactericidal action and may be disregarded, whereas the general condition of the buccal fluids are directly related to the variations in physiological processes of the body. The question of caries is discussed in another place, and we can only indicate here the direction in which we may look for an explanation of the conditions that permit the organisms to commence their operations.

Having briefly reviewed the bacteria of the mouth, the question of dental caries can be more easily comprehended. Other organisms than those touched upon may be concerned, yet a few which will be referred to seem to be more related to the process

than others. The biological characters of some of these are given, the description of the others, mostly well known species, will be found in the text-books of general bacteriology (Sternberg, Migula, Pflügge, &c.).

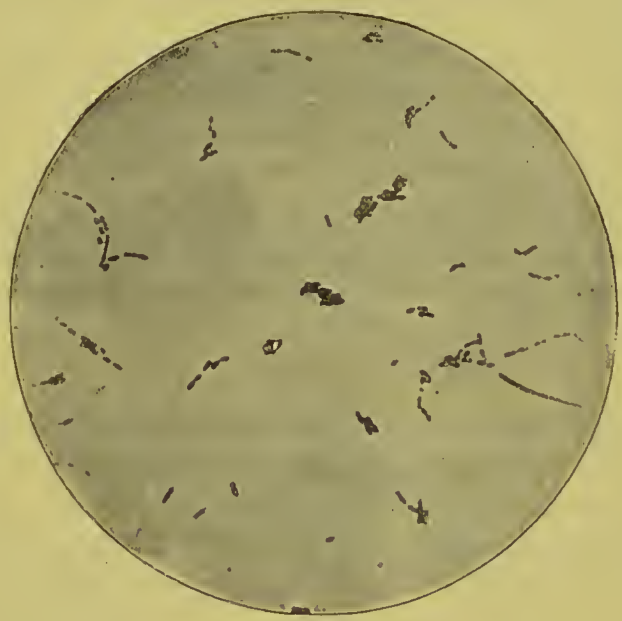
The bacteria concerned in the process, which is allied to putrefaction, are more numerous in the superficial than in the deep layers of the carious dentine. The phase of the process occurring in the two situations is also somewhat different, and tends, in the deeper layers, to be confined to the solution of the calcium salts by the acid formed by the bacteria, while in the more superficial layers the predominant action is one of digestion or liquefaction of the chondrinogen matrix of the tooth. We are thus enabled to make a general division of the process into (*a*) acid production, (*b*) liquefaction.

The organisms concerned also appear to be in some measure influenced by their surroundings, in that the ones of the deep layers are capable of growing with ease in an atmosphere devoid of oxygen, that is, anäerobic, while those of the superficial layers develop best in the presence of oxygen and are äerobic. It must not be supposed that the two classes are entirely distinct, for the anäerobic ones are facultative äerobic, and *vice versâ*. Cultivations made from the deep layers of carious dentine, with the usual precautions to avoid contamination, in a large number of cases give a growth of a short pleomorphic bacillus as well as the streptococcus brevis of the mouth. The staphylococcus albus may also often occur. Besides these, there are to be seen on the coverslip preparations made direct, a number of other bacteria of various forms, some of which may be pleomorphic forms of the bacillus obtained in culture, and others species not yet isolated.

The bacteria obtained from the deep layers, so far as have been met with up to the present, are rapid acid producers when supplied with carbohydrate food. This is an interesting circumstance, as we know that rapid caries rarely goes on under a good filling, although bacteria are undoubtedly left in the dentine. That caries does occur is an undoubted fact, but it develops much less rapidly. The explanation is an easy one; to produce acid, bacteria requires the presence of carbohydrate, although acid may be produced in small quantities from decomposing proteid. The organisms in the carious dentine are supplied with soluble carbohydrate food which gains access from the buccal cavity by capil-

larity. When, however, the supply of carbohydrate is cut off, the organism produces very little acid, and can only attack the dentine direct, the process then becomes a much slower one.

The bacillus which is to be found so often in carious dentine differs from all other bacteria with which I am acquainted, and it has therefore received the name of *B. necrodentalis*.



× 1,000.

FIG. 315.—B. Necro-dentalis. Forty-eight hours' agar cultivation. Stained Gram.

Bacillus necrodentalis. Found in dental caries.

Morphology.—Short bacilli, 0·75 μ broad and 1 to 5 μ long, often associated in pairs and sometimes in chains. The ends of the bacilli are square or rounded. The bacilli tend to involute rapidly, and form swollen or contorted masses not unlike the streptococcus.

In broth the forms are much like cocci owing to the shortness of the elements. The bacilli are slightly motile, most marked on anäerobic cultures.

Stains by the ordinary aniline dyes, with difficulty by c.m.b.; it retains the stain of Gram's method. No partial staining has been noticed, and no spore formation has been observed. The bacilli are killed by exposure to temperature of 70° C. for half an hour.

Biological characters.—An anäerobic, facultative äerobic, non-liquefying, motile bacillus. Non-chromogenic. Does not form spores.

Gelatin plates.—In three days minute colonies appear not much larger than a pin's point. The organism tends to grow downwards into the medium and form fine feathery processes.

Gelatin streak.—In three days a slight dotted growth occurs which, later, sends processes into the medium. The gelatin is not liquefied but becomes a little softened.

Gelatin stab.—Slight dotted growth along the line of puncture from which radiating processes may extend later. No liquefaction occurs.

Gelatin shake.—No gas formed.

Broth.—Twenty-four hours, slight general turbidity with a precipitate that soon increases while the turbidity does not. No indol is given.

Potato.—Forty-eight hours, very slight shining appearance. Considerable involution is seen.

Litmus milk.—Twenty-four hours, no change; forty-eight hours, solid clot, lower portion of which is decolourised, top showing a strong acid reaction. Clot not re-dissolved.

Agar plates.—Minute grey-white colonies, round and regular or wavy with central projection. Microscopically brownish, with slight central dot faintly granular and regular edge.

Glucose broth, lactose broth, starch broth, maltose broth, &c.—Strong acid reaction in forty-eight hours.

Anäerobiosis.—Well marked growth on glucose formate agar. The colonies are much larger than on the äerobic media, and are a brownish colour with a well marked central darker area. No gas is formed on glucose formate broth, but the general turbidity is well marked.

Pathogenicity not determined.

In the superficial layers of carious dentine many bacteria are found, some of them capable of digesting dentine softened by acids, others themselves produce acid, some capable of both functions. The liquefying organisms are generally in large numbers, and among them all those that are capable of liquefying dentine are also liquefiers of blood serum—a fact of considerable practical importance in separating the various organisms concerned in the destruction of dentine from the purely adventitious species. I have also isolated from some of these liquefying bacteria an enzyme, by treating the cultures with alcohol and chloroform, and have obtained an active thymol water solution of an enzyme which is capable of pigesting decalcified dentine, although it contains no living bacteria, as shown by control cultures.

The production of acid and the liquefaction of the tooth cartilage are two methods by which bacteria bring about destruction of tooth substance—that is to say, dental caries—and therefore the bacteria concerned in the process may be conveniently grouped into classes with reference to their principal or predominant functions. Such a grouping is of course not entirely exact, for certain bacteria which produce acids from carbohydrate are also able to liquefy softened dentine (S. aureus, albus, &c.), whilst liquefying organisms may also ferment carbohydrates with the production of acids. Notwithstanding such a merging of the two groups, the chief *rôle* of

certain bacteria consists mainly of one or other of the two processes, and a general grouping is rendered possible.

So far no anäerobic liquefying bacteria have been isolated from the deep layers of carious dentine, some facultative anäerobic liquefiers however have; but even these when obtained from the deep layers do not liquefy until a considerable time has elapsed after their isolation. Pigmentation, another phenomenon often present in caries, is due to the activity of bacteria concerned in the process, and although pigmentation is not of itself a cause of tooth decay, it is a concomitant factor often due to particular organisms, many of the liquefying bacteria producing a darkening of the substratum in which they are growing.

Adopting the two criteria of (*a*) acid production, (*b*) liquefaction, the organisms commonly present in dental caries may be arranged as follows :—

General Distribution of Bacteria in Dental Caries.

Acid-forming bacteria.

(1) Streptococcus brevis. (2) B. necrodentalis. (3) Staphylococcus albus.	Deep layers of carious dentine.
(1) Streptococcus brevis. (2) Sarcina lutea. (3) Sarcina alba (Eisenberg). (4) Staphylococcus albus. (5) Sarcina aurantiaca. (6) Staphylococcus aureus.	Superficial layers of carious dentine.

Bacteria which liquefy dentine (decalcified).

None isolated	Deep layers of carious dentine.
(1) B. mesentericus ruber. (2) B. mesentericus vulgatus. (3) B. mesentericus fuscus. (4) B. furvus. (5) B. gingivæ pyogenes. (6) B. fluorescens liquifasciens motilis. (7) B. subtilis.	Superficial layers of carious dentine.

Another point of interest is that the bacteria found in the superficial layers differ very much with the environment of the given individual, owing to the presence of organisms from the air, &c. The list is, however, a fairly representative one. It will be seen that the Mesentericus or "potato-bacillus" is often present,

and another common organism, B. liq. fluorescens motilis, and the other members of the species are often met with in the mouth. Sarcinæ are also very often present in carious dentine and in mouths in which caries is general.

In the experiments on dentine it was found that the liquefying bacteria would only dissolve dentine when it had been softened previously by the action of acids.

All the foregoing bacteria were obtained from cases of primary caries with which all my work has been associated. Recently Choquet[1] has studied the question of secondary caries or recurrent caries in three teeth previously filled in the routine way. From these three teeth he isolated five organisms.[2]

A culture of one of the organisms obtained was placed in a cavity cut in the central incisor of a sheep. The cavity was filled and nine months later examined. Cultures of the organism introduced were obtained from the cavity and the dentine was apparently softened. Unfortunately no control cavity was cut and filled in the same way but without the introduction of the cultivation. In view of this, and that only one experiment was performed, the uncomfortable suggestion of chance cannot be disregarded. Choquet does not appear to have found any organisms mentioned by other writers, but this is not surprising considering the methods of media preparation adopted.

Dobrzyniecki[3] gives the following list of organisms as occurring in carious dentine. The list agrees on the whole with my own work, but one organism, B. gangrænæ pulpæ, has not as yet been obtained. The cultural characters of this organism, first described by Arkövy, has already been given.

Chief bacteria of dental caries (Dobrzyniecki):—

B. gangrænæ pulpæ.

Staphylococcus aureus.

Streptococcus pyogenes (S. brevis ?).

Staphylococcus albus.

Sarcinæ lutea.

A considerable number of chromogenic organisms are to be

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[1] *Dental Cosmos*, October, 1900.

[2] One of these is probably B. necrodentalis, but in the absence of proper description on standard media it is impossible to make certain.

[3] *Loc. cit.*

found associated with dental caries, but most of them do not produce pigment at the temperature of the body. Some of them are capable of producing a marked discolouration of the culture medium, as for instance, B. furvus[1] and B. fuscans.[2] The question of pigmentation of the teeth and the colouration of the various deposits in the mouth is as yet almost entirely uninvestigated. Some few bacteria have been described other than the common and well-known chromogens.[3]

The later stages of untreated caries, and of early caries, too, are often accompanied with inflammation of the pulp and its resulting gangrene, afterwards leading to alveolar abscess. Pulpitis is not always due to the presence in the pulp of the bacteria themselves, the soluble toxines and acids produced by the activity of the organisms finding their way through the dentinal tubules to the pulp cavity. The bactericidal power of the pulp has not been determined, but it is probable that there does exist some considerable resistance to bacteria, for it has been proved how often dentine of repair is produced even when the breach of dentine is extremely large.[4]

The Bacteriology of the Pulp.

Miller[5] has given some attention to the bacteriology of the pulp, especially to the question of pulpitis, and his results may be summed up as follows:—The constant presence of certain forms of bacteria, chiefly cocci and diplococci, in all gangrenous pulps examined; in a considerable number long filaments were also found with a limited number of bacilli. Pure cultivations of four of these organisms were obtained and found to be capable of decomposing albuminous matter with the production of a quantity of evil-smelling gas. One coccus in particular seemed to be always present, and was also capable of producing local abscess formation when inoculated into mice. Miller is inclined to attribute the chief *rôle* of the

[1] *Dental Cosmos*, April, 1900, p. 323.

[2] "Micro-organisms of Mouth," p. 93.

[3] M. lactericeus, B. lutea (*Centralb. für Bak.*, Bd. xxi., p. 833, 1897), B. rosa (*Trans. Odonto. Soc.*, p. 176, 1898).

[4] *Dental Cosmos*, November, 1900, &c.

[5] *Dental Cosmos*, July, 1894, p. 505. See also *Odont. Bl. Berlin*, 1900, v., 263, and *Zierler. Zahnarztl Rundschau.*, 1900, ix., 6531.

destruction of the pulp to the cocci, which he adds may, however, be assisted in their action by the bacilli. These bacilli were not pathogenic when pure cultures were inoculated into animals; impure cultures, containing both cocci and bacilli, produced a much more marked reaction than the injection of the cocci alone. The process, therefore, appears to be a symbiotic one, in which more than one organism is concerned.

Arkövy considers that the organism described by himself, and which has already been given, is the chief factor in the production of pulp gangrene.

So far my own researches tend to confirm Miller's work, and to corroborate what is said concerning the common presence of cocci in gangrenous pulps. From some pulps the B. necrodentalis has appeared on the culture tubes, as well as certain cocci, and I am inclined to think that the bacilli mentioned by Miller are the same as the one mentioned; especially is this probable, as the pleomorphism of the organism is so well marked.

Of the fate of the bacteria of the mouth we know but little beyond the fact that they must be swallowed constantly, and that those that are not destroyed by the gastric juice pass on into the intestine, where they may set up digestive troubles. Some may continue to live in the digestive tract, others are excreted. The presence of carious teeth thus contributes to digestive disturbance by increasing the numbers of *particular* species of organisms that are swallowed.

The cleansing of the teeth by mechanical and antiseptic means does reduce the number of bacteria present in the mouth, and to refrain from so doing because, forsooth, caries cannot thereby be entirely and certainly prevented, is as illogical as abandoning the prophylactic isolation method of treatment for infectious disease; in fact, as Newsholm[1] says, "it would be as foolish for a city council to dismiss its fire-brigade staff on account of imperfections in the fire-extinguishing apparatus, or because the force is unable to prevent occasional big conflagrations." There yet remain a considerable number of bacteria which are known to occur from time to time in the mouth, but which have not as yet been satisfactorily identified with any of the pathological conditions of the buccal cavities.

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[1] "Epidemic and Pandemic Diphtheria," p. 192.

A large number of these organisms require systematically working out before the subject can be reduced to a satisfactory whole. The chromogenic bacteria have also been omitted or incidentally referred to in the passing. Some of these chromogens are commonly present, and are no doubt concerned in the pigmented deposits that are often found, such as the sulphur-coloured masses of tartar, green stain, and many other conditions, but the work is at present much too fragmentary to make any definite statements regarding many of these interesting conditions.

In dealing with some of the problems incident on the bacteria of the mouth it has been necessary to review a good deal of ground that is not yet fully investigated, and an attempt therefore has been made to indicate the questions requiring further investigation.

It will be seen from the foregoing survey that the subject is of extreme importance to dental surgery, in practical as well as scientific application, and although a proper knowledge of the biology and physiology of micro-organisms can only be attained by systematic laboratory work, much of which necessitates special apparatus, nevertheless a general conception of the principles of bacteriology, with their application to conditions and phenomena of every day life and their especial relation to the region of the mouth, are of undeniable moment to the dental surgeon.

Scheme for the Systematic Examination of Bacteria, &c.

(*A*) *Morphology.*

(1) Description.—Bacillus, coccus, yeast, mould, &c.

(2) Motility.—If motile, degree to be stated.

(3) Flagella.—Number and distribution.

(4) Spores.—When found, on what media and at what temperature.

(5) Staining Reactions.—With carbolic methylene blue, Gram, &c.

(6) Pleomorphism.—If marked, and medium showing it.

(*B*) *Cultural Reactions.*

(7) On broth (37° or 20°).—Universal turbidity, scum, sediment, indol.

(8) Gelatin Stab (20°).—Growth on surface and in depth, liquefaction, gas, pigment.

(9) Gelatin Shake (20°).—Gas, liquefaction, colonies in depth.

(10) Gelatin Streak (20°).—Character of surface growth, pigment, &c.

(11) Gelatin Plates (20°), Agar Plates.—Character of colonies, liquefaction of gelatin, pigment.

(12) Agar (37° or 20°).—Character of surface growth, pigment.

(13) Blood Serum (37° or 20°).—Character of growth, pigment.

(14) Potato (37° or 20°).—Character of growth, pigment.

(15) Litmus Milk (37° or 20°).—Acid, alkali, clotting, dissolution of casein.

(16) Dextrose Broth—Lactose Broth (37° or 20°).—Production of acid or gas.

(17) Anäerobiosis determined by growth on glucose formate media.

(18) Growth on Special Media.—At the discretion of the observer, but the composition of such must always be clearly stated.

(19) Pathogenicity.—For what animals pathogenic, and the *post-mortem* appearances produced.

The morphology on the various media should be cited and any change of form specially noted.

The standard reaction that gives the best general results is the plus 10cc. normal NaOH per litre (Eyre).

Note.—This scheme for the description of bacteria has been introduced with a hope that it may assist the investigator. It embodies the present conception of bacteriological detail absolutely essential for proper diagnosis, and in accordance with that given in Pake's "Practical Hygiene," where other particulars of methods of staining, &c., are given.

CHAPTER VII.

Caries.

Caries is by far the most prevalent of the diseases of the human race. It is found amongst all races, but more particularly those where civilisation is more advanced.

A.—PREVALENCE OF CARIES.

(1) ANCIENT RACES.

Mr. J. R. Mummery[1] examined skulls from "the ancient tumuli of Wiltshire and other parts." In 68 skulls from the older Wiltshire tumuli which date back to the Stone Age only two cases of caries were found, one on an approximal surface and one on an occluding surface. These people were a pastoral and not an agricultural race. They lived by the chase and their customs were barbarous. Among 44 skulls of a similar race inhabiting more northern districts of England, 9 cases of caries were found, 4 on occluding and 5 on approximal surfaces. In a later race (Bronze Period), in 32 skulls there were 7 cases of caries, 6 on approximal and 1 on occluding surfaces. This race was probably the agricultural population of the maritime districts referred to by Cæsar in his Commentaries. The skulls of Romans found in England also furnish ample evidence of caries. In 143 examples about 32 per cent. showed signs of caries, and in one instance the disease being extensive. Passing to the Anglo-Saxon period we find that in 76 skulls caries was present in 12 cases.

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[1] *Transactions of the Odontological Society of Great Britain*, vol. ii., New Series. Over 3,000 skulls were examined, and of these 1,658 were tabulated, the remainder being rejected either in consequence of their doubtful authenticity, or because too many teeth were missing. This work of Mr. Mummery entailed a vast amount of labour, and is one of the most valuable contributions to the dental literature of the sixties.

Egyptian mummies to the number of 36 were examined, and in 11 signs of approximal decay were present.

(2) EXISTING PRIMITIVE RACES.

Of the primitive races examined by Mr. Mummery, and of which statistics are given, all showed some evidence of caries. The other points brought out by his statistics are :—

(1) That in races existing wholly or in great part on vegetable food caries is more prevalent than in races whose diet consists mainly of meat.

(2) That general hygienic conditions play quite as important a part as diet, and

(3) The importance of a regular and sufficient supply of food.

The following is a *résumé* of the section of Mr. Mummery's paper dealing with existing primitive races :—

The Esquimaux, a people of nomadic habits inhabiting the littoral in the extreme north, living almost entirely on a meat diet, of which huge quantities—ten to fourteen pounds per person—are consumed daily. In 69 skulls examined only one case of caries was found. In another instance two molars had been removed.

The Indians of the North-West Coast of America.—Diet chiefly dried fish ; 51 skulls showed two cases of caries.

North American Indians (interior).—Diet, meat, with occasional addition of roots. Often subject to great privation. Twenty-one skulls showed two cases of two carious teeth in each.

The Gauchos, a mixed race of Indian and Spanish blood in the Argentine Republic, occupied on ranches and living mostly on horseback. Diet entirely " roast beef," with Paraguay tea taken without sugar as their sole beverage. No record of skulls examined is given, and only one case of toothache could be traced. In Indians of the same race inhabiting the towns and indulging greatly in artificial diet (acid confectionery and inferior wines, &c.) caries was extensive.

Arabs of the Nubian Desert, living on a diet consisting almost wholly of the milk and flesh of camels, possess, according to observers, sound and well-formed teeth.

The Fiji Islanders, a robust race, addicted to cannibalism ; 38 skulls showed only two instances of caries, one case in which two teeth were affected, and one in which the caries was extensive.

The New Zealanders, whose habits resemble the Fijians ; in 66 skulls there were two cases of caries, in one of which two teeth and in the other four were affected.

The inhabitants of Eastern Polynesia.—Diet, vegetable products and fish. In 70 skulls there were eight cases of caries, a large proportion extensive.

The Sandwich Islanders.—Diet mainly vegetable, with small amount of meat. In 21 skulls there were four cases of caries, two of which were very extensive.

The Australian races.—"For the most part improvident savages, and spending their lives in alternate feasting and famine." Diet mainly meat; 132 skulls showed 27 cases of caries, some being extensive.

The Tasmanian race closely resemble the Australian in habits. In 33 skulls examined 9 cases of caries were found, and in the majority of these a considerable number of the teeth were affected.

The Zulu Kaffirs.—Diet, milk and vegetables, meat being consumed on special occasions, as in the training of their warriors. In 49 skulls there were seven instances of caries, five of which were of very limited extent.

The African tribes which supply the slave markets.—The most feeble of the African tribes, mainly inhabiting unhealthy districts. Diet, mixed, principally vegetable; 268 skulls of slaves who had died of disease or exhaustion were examined, in 66 caries was present, many of the cavities being in approximal surfaces. In no less than 16 of the cases the whole of the molars and premolars were carious.

The Bushmen.—Dwarfs inhabiting the deserts of South Africa. Diet, chiefly meat, but in times of scarcity, edible roots, locusts, &c. In 29 skulls six cases of caries were found, the majority being extensive.

The Natives of Southern India.—Diet of a varied character, frequently of an unwholesome nature. Rice forms the staple food, sweetmeats are much indulged in. In 71 skulls 10 cases of caries, in three of which six teeth were involved.

The Natives of Northern India.—Diet, vegetables of a simple and wholesome character, staple food being wheat. In 152 skulls nine cases of caries, and in no instance more than two teeth affected.

An interesting report on the examination of old human crania contained in the principal museums of the United States is published in the *Transactions of the American Dental Association*, 1894, and is well worthy of perusal by those wishing to investigate the subject.[1]

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[1] The following is a *résumé* of the results obtained:—

Total number of teeth examined	.. ...	46,017
,, ,, ,, diseased	... ...	11,338
,, percentage of diseased teeth	... ...	24·6

The crania were grouped geographically.

Country.	Number of Teeth Examined.	Number of Teeth Diseased.	Percentage of Diseased Teeth.
South America	6,719	2,462	36·4
Central America	930	250	26·8
North America	27,362	5,811	21·2
European (including Anglo-Americans)	3,422	1,373	40·4
Pacific and Sandwich Islands	2,738	417	15·25
Egyptian	3,306	689	20·8
Asiatic	2,180	336	15·4

(3) MODERN CIVILISED RACES.

In the modern civilised races the percentage of mouths containing carious teeth has increased to an alarming extent. The collective investigations of the British Dental Association has shown that out of 10,500 English and Scotch girls and boys averaging 12 years of age, there were no less than 37,000 unsound teeth (deciduous and permanent). In all, 86 per cent. of the mouths showed that caries in some form or other was present. The children examined belonged to the Poor Law schools, workhouses and reformatories. In 560 boys, average 13 years 7 months, belonging to one of our large public schools, 701 of the permanent teeth had been lost, while 3,521 were carious. In 87 per cent. of the boys caries was present. In America, Germany, Hungary, and other countries, similar investigations have yielded very similar results. Unghvari's (Hungary) and Berten's (Würzburg) investigations show the percentages of 87·2 and 83, while Röse, in an extended investigation in Baden and Thuringia, and Fenchel (Hamburg) showed caries present to the amount of 98·75 per cent. and 96·4 per cent. respectively. The figures of these latter observers would tend to show that the teeth of English children compare favourably with those of German.[1]

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[1] The following communications on this subject are of interest :—

The various reports of the School Children's Committee appointed by the British Dental Association.

Voerckel and Weber : "On the Care of the Teeth of Children in the National Schools of Elberfeld and Witten," *Deutsche Monatsschrift für Zahnheilkunde*, translated in Ash's *Quarterly Circular*, December, 1899, and March, 1900.

Röse : "On the Decay of Teeth in the National Schools of Germany," *Oesterreichisch Ungarische Vierteljahrsschrift für Zahnheilkunde*, translated in Ash's *Quarterly Circular*, March and June, 1895.

Unghvari : *Oesterreichisch Ungarische Vierteljahrsschrift für Zahnheilkunde.*

Berten : *Aus den Sitzungsberichten der Würzburger physik. med. Gesellschaft.*, 1894, xv. *Sitzung*, November 17.

Fenchel : *Die Caries Frequenz Hamburger Schulkinder, Correspondenzblatt für Zahnärzte*, October, 1893.

Ottofy : Addendum in Parreidt's "Compendium of Dentistry," Chicago, 1889, p. 57.

Cunningham, C. M. : "An Examination of Teeth in the Arran Islands, Co. Galway," *Journ. Brit. Dent. Assoc.*, vol. xviii., p. 652.

(B) FREQUENCY IN INDIVIDUAL TEETH.

The liability of the various groups of teeth to caries differs. Statistics which deal with this question are nearly all derived from records of extractions, and it is needless to say that such records will not correctly show the relative tendency to caries in the different teeth. The first permanent molars are more prone to caries than other teeth, and the mandibular more than the maxillary. These teeth are erupted early, and the liability to caries is due to the unhygienic conditions in the mouth at this period rather than to any inherent structural defect. The caries nearly always commences on the occluding surface. These teeth are probably less liable to approximal decay than the superior premolars. The second molars probably follow the first molars in liability to caries, the mandibular being attacked with more frequency than the maxillary. It is extremely difficult, without reliable statistics, to place the incisors and premolars as regards their liability to caries. Judging from experience there seems little to choose between the first and second maxillary premolars in this respect, but with regard to the mandibular premolars the liability to caries is more marked in the second than in the first. The mandibular incisors are comparatively immune to caries, and this is due as much to their shape as to the constant mechanical cleansing action of the tongue and lips. The liability of the third molars to caries, in mouths where all the teeth are present, is attributable to difficulty in keeping them free from the lodgment of food *débris*.

Frequency in relation to sex and age.—It is generally supposed that caries is more frequent in females than males. The observation of Röse[1] on 6,280 children, boys and girls being about equally divided, showed the percentage of caries in boys to be 26 and girls 26·2. Caries is more active during the period of growth of the individual than subsequently. A fresh period of activity often appears with conditions which lead to exposure of the roots of the teeth, caries commencing in the cementum.

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[1] Röse "On the Decay of Teeth in the National Schools of Germany," *Oesterreichisch Ungarische Vierteljahrsschrift für Zahnheilkunde*, translated in Ash's *Quarterly Circular*, March and June, 1895.

(C) PHENOMENA.

(1) MACROSCOPICAL.

(*a*) **Enamel.**—In enamel, the naked eye appearances of caries can be best observed upon the approximal side of a molar or premolar. The earliest indication that caries is commencing is that the enamel loses its normal polish and translucency. Following this a whitish spot appears which gradually becomes darker. When the process is slow the discolouration is more marked than when the process is rapid. As the enamel prisms become disorganised they are mechanically washed away and a cavity is left which varies somewhat in form, being sometimes broad and shallow with indistinguishable margins, at other times deep with sharp rugged margins. The destruction advances until the dentine is reached. When the decay which has started on an approximal surface reaches the under surface of the enamel of the crown (as is frequently the case in molars and premolars), the enamel at that part appears bluish-white and translucent, especially by artificial light. This appearance is produced by the decalcified tissue which has not been removed by the saliva. As the caries reaches the surface, the enamel appears whiter, and eventually becomes so thin that mastication fractures it, and the under surface is found to be of a soft cheesy consistency. Caries commencing in the dentinal aspect of the enamel and proceeding to the surface is known as "secondary enamel decay."

(*b*) **Dentine.**—The appearances of caries in dentine differ considerably from those in enamel. This tissue becomes of a tough cartilaginous consistence, and not soft and cheesy as with the enamel. After softening, the tissue undergoes disintegration and a cavity is formed. Pigmentation accompanies the process and, as in caries of the enamel, the discolouration depends to a great extent upon the slowness of the disease.

It may spread in any direction and with varying degrees of rapidity. The rapidity of its progress depends upon the intensity of action of the various ferments. The direction taken is determined, to a great extent, by the structure of the tooth. In a tooth of ordinary structure the cavity formed is somewhat cone-shaped, the apex of the cone being towards the pulp. In badly developed teeth with a large number of interglobular spaces the decay will extend laterally and considerably undermine the enamel, whilst in

teeth where the dentine is well calcified the decay will extend more in the direction of the pulp than laterally, giving rise to what is known as "penetrating caries."

In hypoplastic teeth the caries often extends rapidly near the junction of the enamel with the dentine and causes the enamel to break away, producing an appearance as illustrated in fig. 320.

FIG. 320.

"**In rapid caries**" the dentine can be removed in large leathery masses, the action of the acid being more rapid than that of the peptonising organisms. This condition is called "**caries humida.**" When the carious process is slow the action of the peptonising organisms almost keeps pace with the action of the acids.

(*c*) **Cementum.**—Caries of cementum is less common than caries of the dentine or enamel. It generally starts at the neck of the tooth, though it may attack any portion of the root when the roots are exposed through loss of the periodontal membrane. The cemental tissue is first softened, and disintegration follows leading to shallow cavities. The cavities become widely extended but are seldom deep owing to there being no circumscribed points of retention or foci of decay. An exception, however, occurs at the angle formed by two roots of a molar, the cavity at these points often becoming deep.

(*d*) **Enamel cuticle.**—The naked-eye appearances of decay of the enamel cuticle are a more or less pronounced discolouration.

(*e*) **Phenomena accompanying caries** :—

(i.) Translucency.

(ii.) Pigmentation of the disintegrated parts.

(i.) **Translucency.**—If the dentine of a tooth in which caries is in progress be examined, it will be found that in the part situated between the pulp and the caries the dentine appears translucent (fig. 321). This translucency is best observed in those teeth where

the enamel only is attacked and the dentine is perfectly sound. The shape assumed is that of a cone with the apex towards the pulp, and on either side of the zone will often be seen two opaque lines.

There is a difference of opinion as to the cause of this translucency. The opacity of normal dentine is due to the matrix and the contents of the tubes having different refractive indices. If

FIG. 321.

from any cause these indices are approximated the dentine becomes translucent. The difference in the refractive indices may be removed either by the matrix being transformed so as to resemble the contents, *i.e.*, by *decalcification of the matrix*, or by the tubes becoming filled with materials resembling the matrix, *i.e.*, by *calcification of the tube contents*. This latter explanation is supported by the following facts :—

(*a*) Irritation of the dentinal fibrils causes activity in the pulp, leading to the formation of adventitious dentine at the point corresponding to the commencement of such fibrils on the surface of the pulp.

(β) The diameter of the tubes, according to Walkoff and Baume, is distinctly lessened in the translucent zone.

(γ) Chemical analyses of the dentine forming the translucent zone have been carried out by Miller and Jeserich. The former found 71·9 per cent. ash from translucent zone dentine and 72·1 per cent. from the normal dentine of the same teeth, a difference which is quite likely to be due to an error of experiment. Dr. Jeserich's results gave 68 per cent. for the normal and 69·5 per cent. for the translucent dentine. The experiments, therefore, do not point to decalcification as the cause of translucency.

(δ) Stains do not readily affect the translucent zone. Partially decalcified dentine is readily stained with eosin, but the stain has little effect on the translucent zone.

(ϵ) Mr. Charters White has found that in specimens in which the dentinal tubes are permeated with coloured collodion, the tubes in the translucent zone are only slightly permeable.

(ζ) The translucent zone does not bound the carious dentine laterally as might have been expected if due to decalcification. The dentine affected is limited to the portion containing fibrils which have been exposed by the carious process.

(η) In artificial caries the translucent zone is absent.

(θ) In caries progressing in pulpless teeth the translucent zone is not present. Miller examined sixty teeth which had been worn in the mouth on plates. Most of the teeth showed various stages of decay, but translucency was only present in one. Even in that one it was impossible to say that the translucency had not occurred when the pulp was alive.

In favour of the theory that the translucent zone is due to decalcification of the matrix are the statements of certain observers that the zone is present in teeth used as artificial substitutes.

Mr. F. J. Bennett[1] states that in some specimens he has noticed the tubes thickened and enlarged in the translucent zone. He is of the opinion that in a specimen of a maxillary central incisor, which had been mounted on a plate and afterwards affected by caries, he found a translucent zone. It is extremely difficult to be quite sure that the translucency in this tooth was not present previous to its use as a substitute.

(ii.) **Pigmentation.**—The pigmentation accompanying caries

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[1] *Trans. Odonto. Soc.*, vol. xxvii., 1895, p. 155.

varies considerably in degree, from a pale yellow to a black; the more acute the process, as a rule, the lighter the colour. That the discolouration is merely incidental and does not form an active part is practically certain, as it is produced solely by outside agency, and is not confined to carious teeth, being also seen in dentine free from caries. The discolouration is in all probability produced by the action of chromogenic bacteria.

(2) CHEMICAL.

The chemical changes which take place consist in a decrease in the amount of lime salts, with loss also of organic matter. In analyses undertaken by Miller it was found that carious dentine contains only about $\frac{1}{13}$ of its original amount of lime salts, while the organic material is also reduced by $\frac{2}{5}$.

(3) MICROSCOPICAL.

(*a*) **Enamel.**—For examining microscopically, thin sections must be prepared by grinding, and stained to show the micro-organisms.

Sections of carious enamel (fig. 322), according to Dr. Leon Williams and others, show the surface to be covered with a felt-like mass of micro-organisms. The enamel is decalcified between the rods and the interstitial cement substance—the enamel globules thus unbound are either dissolved or washed away. The enamel may be penetrated to a considerable depth before any breaking down of the tissue occurs.

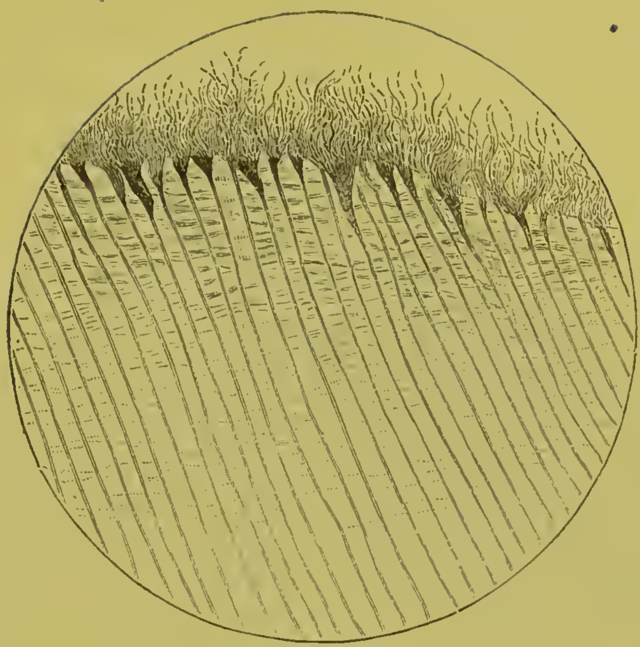
The micro-organisms, after the interprismatic substance is dissolved, work their way between the prisms and so assist in the disintegration of the tissue.

An interesting contribution by Dr. Leon Williams to the study of caries of the enamel was published in the *Cosmos*, March, 1897, *et seq.*

The various stages of caries of the enamel are shown in figs. figs. 322 to 330.[1]

The four following diagrams are from drawings by Dr. Leon Williams :—

[1] I am indebted to Dr. Leon Williams for the use of the blocks of figs. 322 to 325, and also for the photo-micrographs reproduced in figs. 326 to 330.

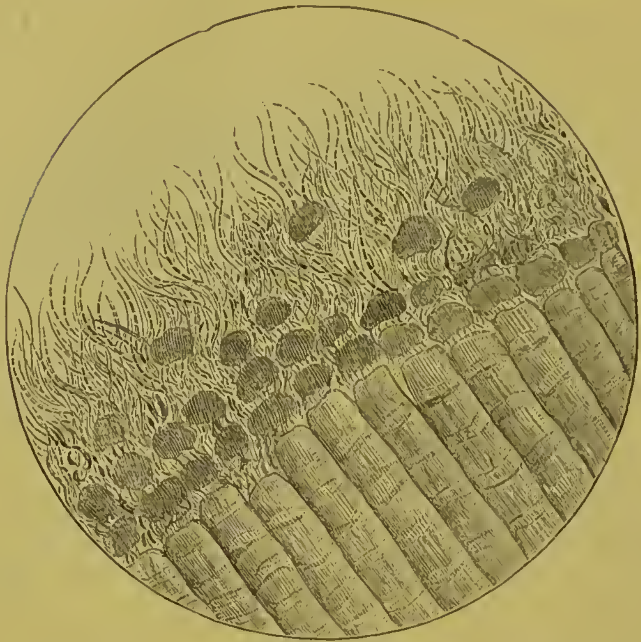


x 800 diameters

FIG. 322.—Showing commencement of the carious process. The felt-like mass of micro-organisms is seen attached to the surface. The cone-shaped cavities between the enamel prisms produced by solution of the cement substance between the enamel rods are also shown.

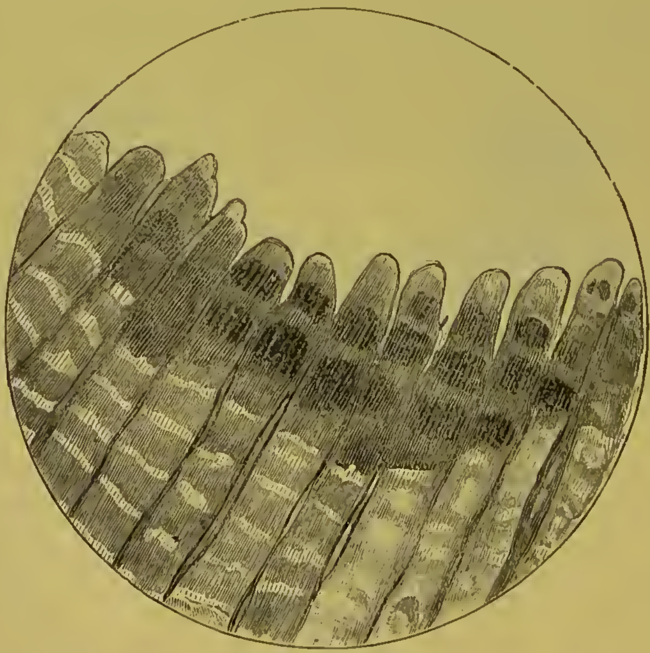
x 800 diameters.

FIG. 323.—Showing the commencement of the formation of a carious cavity in the enamel. The cavity is seen to be lined with the felt-like mass of micro-organisms similar to those seen on the surface of the enamel at the commencement of decay.



× 1,500 diameters.

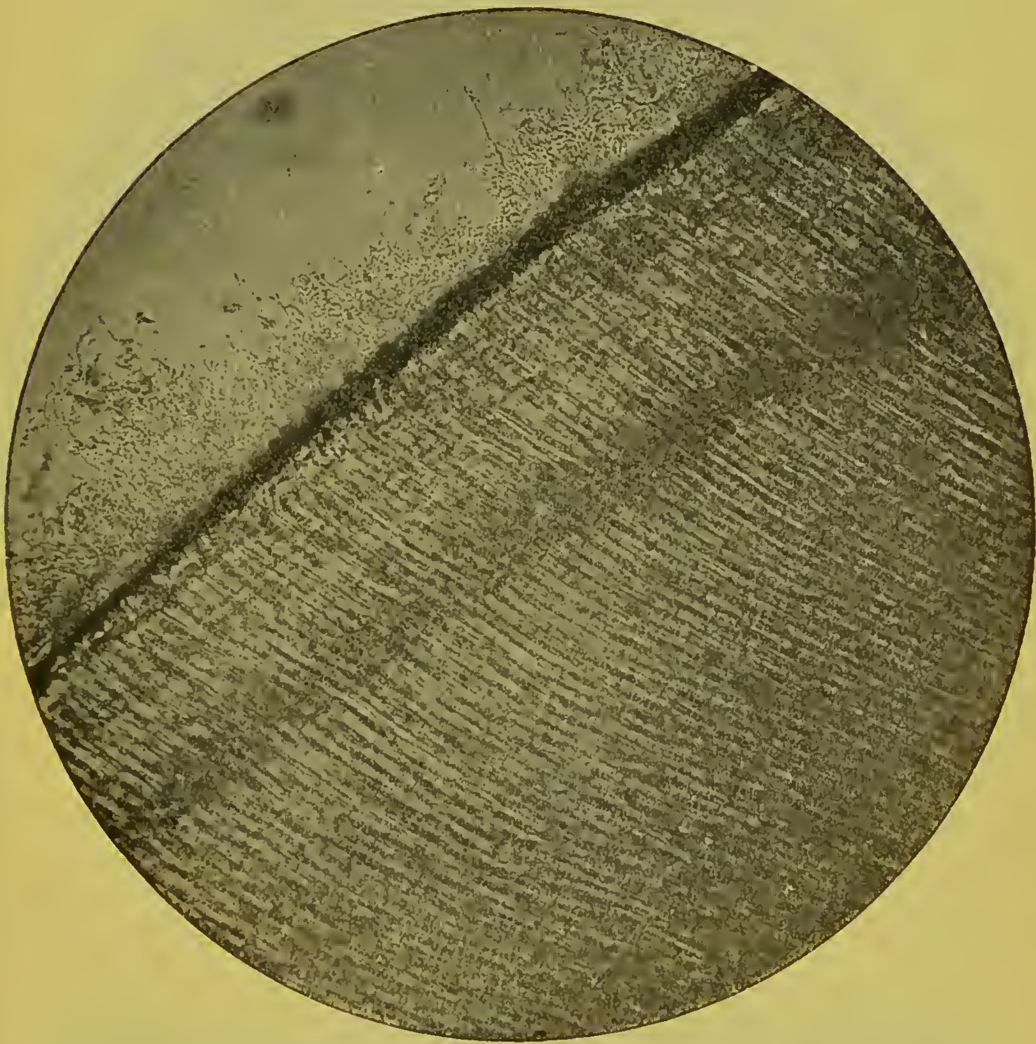
FIG. 324.—The *modus operandi* of the process of caries, according to Dr. Leon Williams, vary somewhat in different specimens. In this specimen the sectional masses of the enamel rods are being set free by the solution of the cement substance which unites them.



× 1,500 diameters.

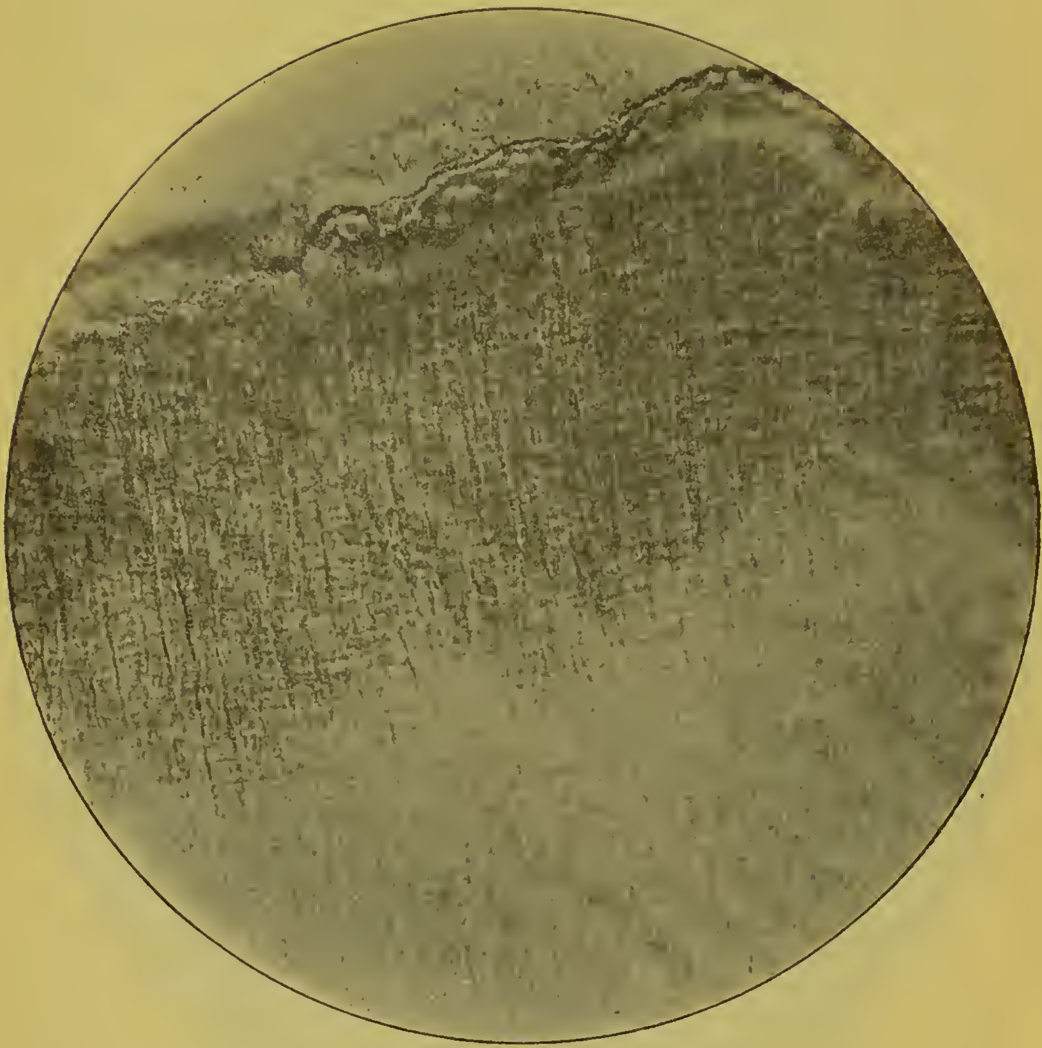
FIG. 325.—The felt-like mass of micro-organisms has been removed to show the action of the acids on the ends of the enamel rods at the decaying surface.

The five following figures are from sections of carious enamel prepared by Dr. Leon Williams :—



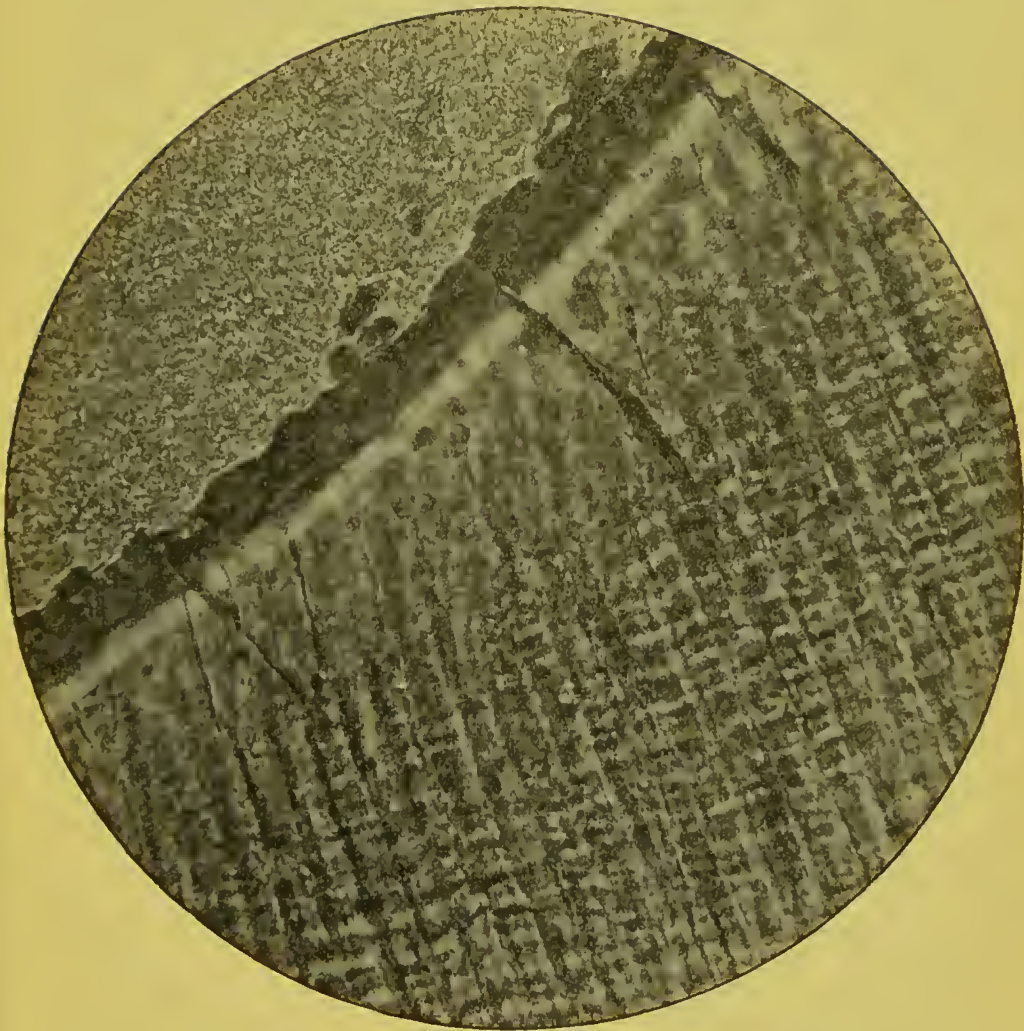
× 300.

Fig. 326.—Section showing felt-like mass of micro-organisms attached to surface of enamel. Photo-micrograph by Dr. Leon Williams.



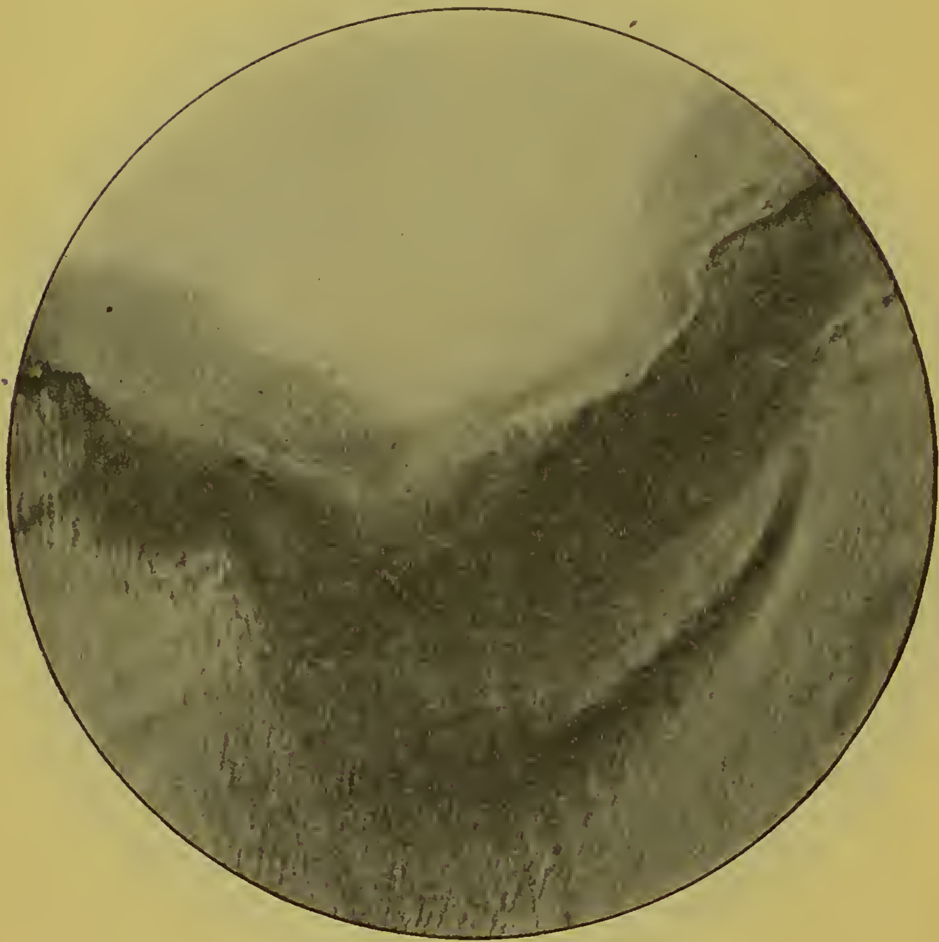
× 800.

Fig. 327.—Showing commencement of caries. Enamel rods separated by solution of cement substance and discoloured by action of acid. From a photomicrograph by Dr. Leon Williams.



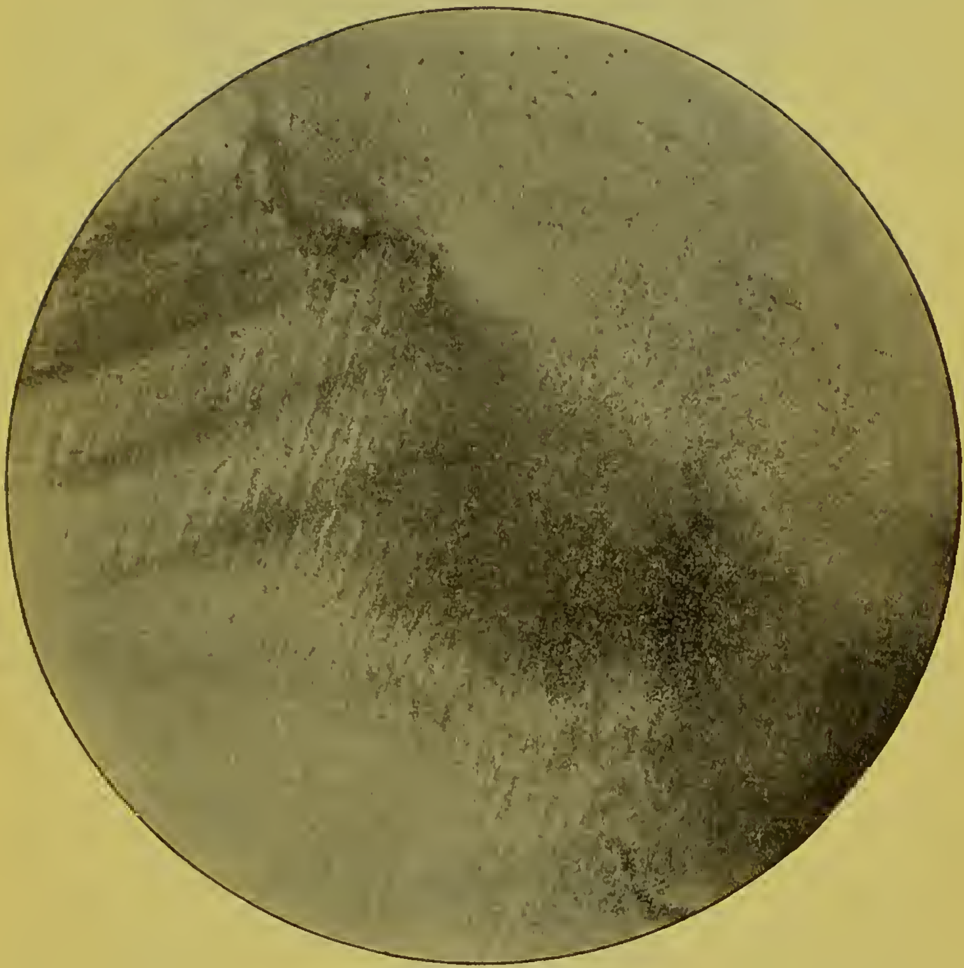
× 1,200.

FIG. 328.—Section of carious enamel, showing destruction of tissue by solution of cement substance around enamel rods and globular bodies. From a photo-micrograph by Dr. Leon Williams.



× 300.

Fig. 329.—Section showing progress of slow decay marked by deep discolouration of the tissue. The felt-like mass of micro-organisms on the surface is also seen. From a photo-micrograph by Dr. Leon Williams.



× 800.

Fig. 330.—Similar to the section shown in fig. 329, but under a much higher power. At the upper left hand corner the ends of the enamel rods are shown projecting, thus demonstrating that the cement substance is first acted on by the acid of decay. From a photomicrograph by Dr. Leon Williams.

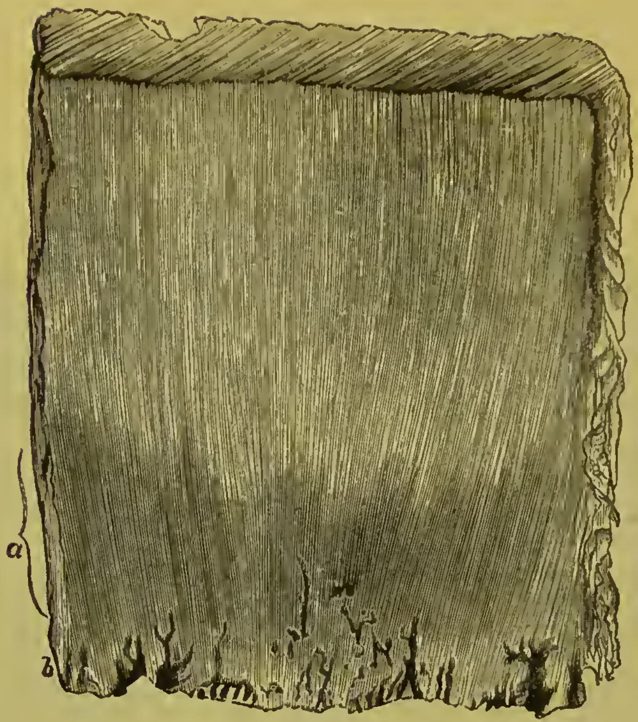


FIG. 331.—Secondary enamel decay. (*a*) Partially decalcified enamel, which has slightly taken the staining material; (*b*) zone of infected enamel, showing masses of micro-organisms working their way into the decalcifying zone (Miller).

FIG. 332. Disruption of prisms in secondary enamel decay (Miller).

(*b*) **Dentine.**—If longitudinal sections of carious dentine which have been stained to demonstrate micro-organisms be examined microscopically, the following points will be observed.

Under a low power (80 mag.).—Bordering the surface (fig. 333) the dentine is excavated in an irregular manner, the cavities presenting no definite shape (*a*). A little deeper in the substance of the dentine irregular masses of stain can be detected (*b*), and in places the stain presents a globular appearance (*c*). Lower down streaks of stain are to be seen (*d*), while still further down the dentine is unstained (*e*).

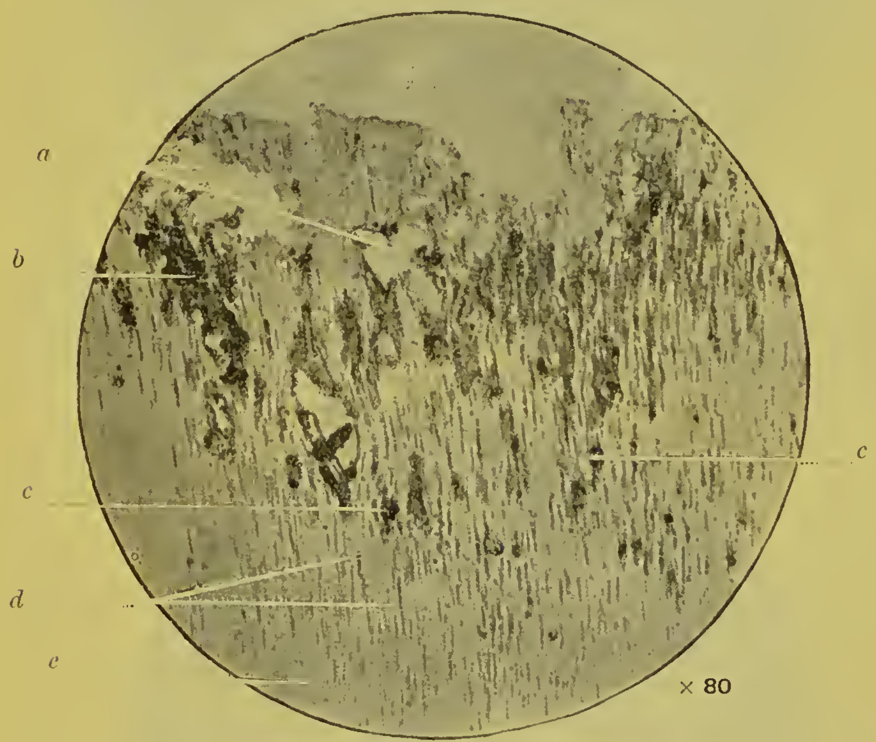


Fig. 333.—Longitudinal section of carious dentine. Photo-micrograph by Mr. A. Pringle.

Under a higher power (150 mag.)—Tracing the process in the reverse order, namely, from within outwards, we shall notice :—

(i.) That the unstained part (*e*) is dentine in a decalcified condition.

(ii.) The streaks of stain (*d*) are micro-organisms occupying the dentinal tubes.

(iii.) The globular masses are micro-organisms occupying the tubes and the structure between the tubes. In other words, the

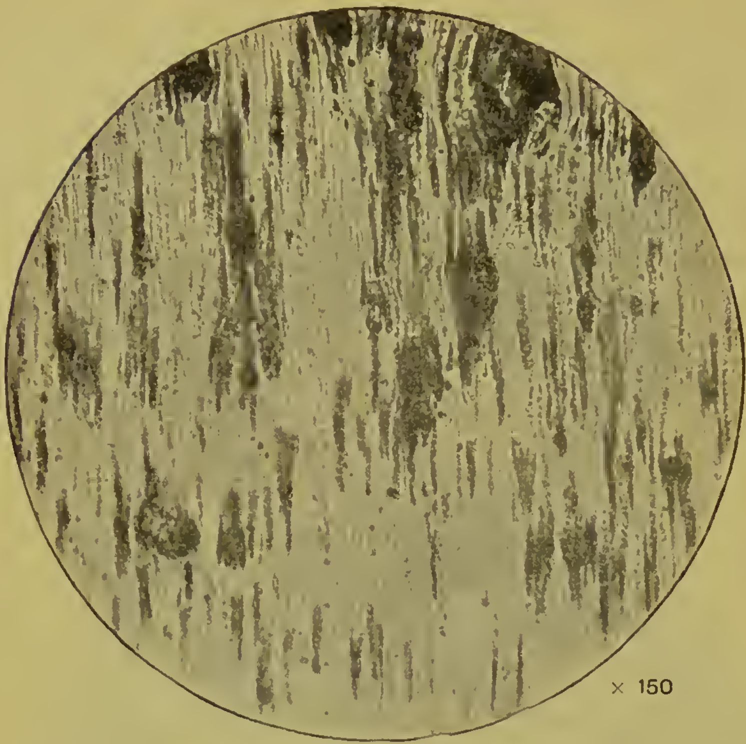


Fig. 334.—Longitudinal section of carious dentine, showing liquefaction foci. Photo-micrograph by Mr. A. Pringle.

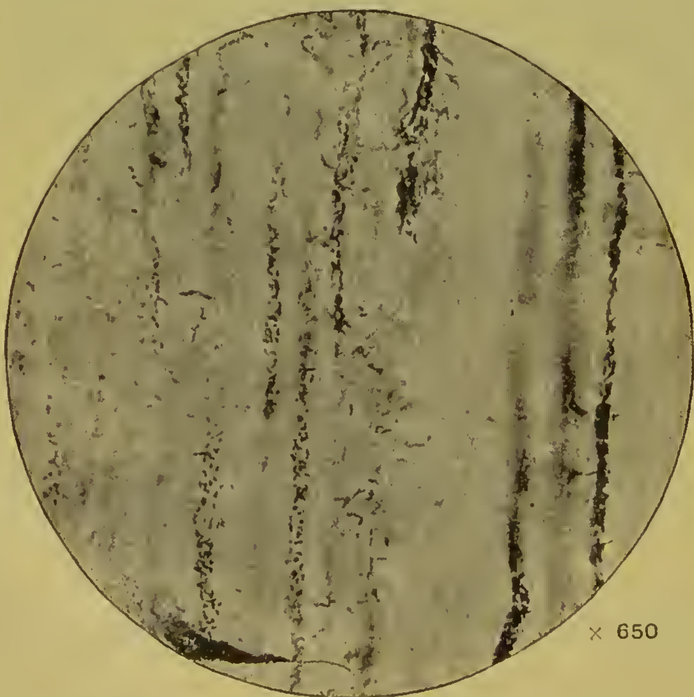


Fig. 335.—Longitudinal section of carious dentine, showing rod-shaped organisms in tubes. Photo-micrograph by Mr. J. Howard Mummery.

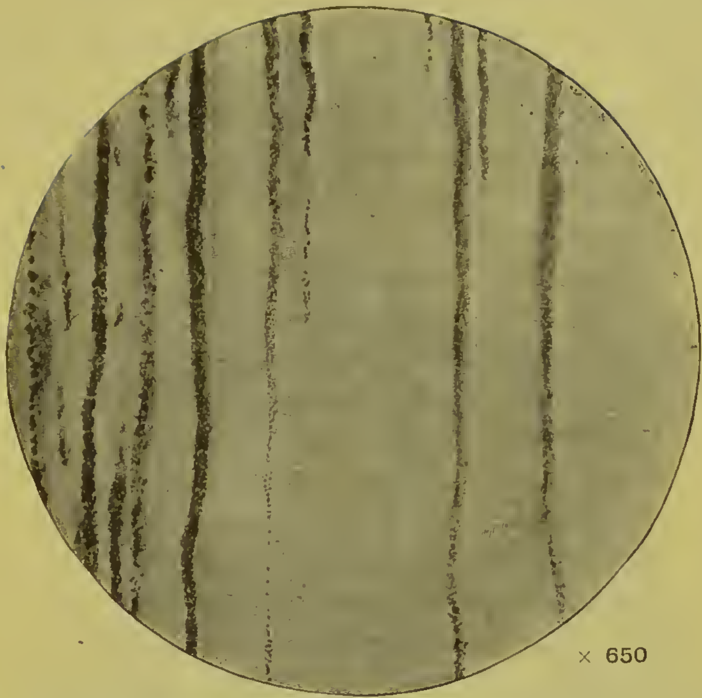


Fig. 336.—Longitudinal section of carious dentine, showing tubes filled with micrococci. Photo-micrograph by Mr. J. Howard Mummery.

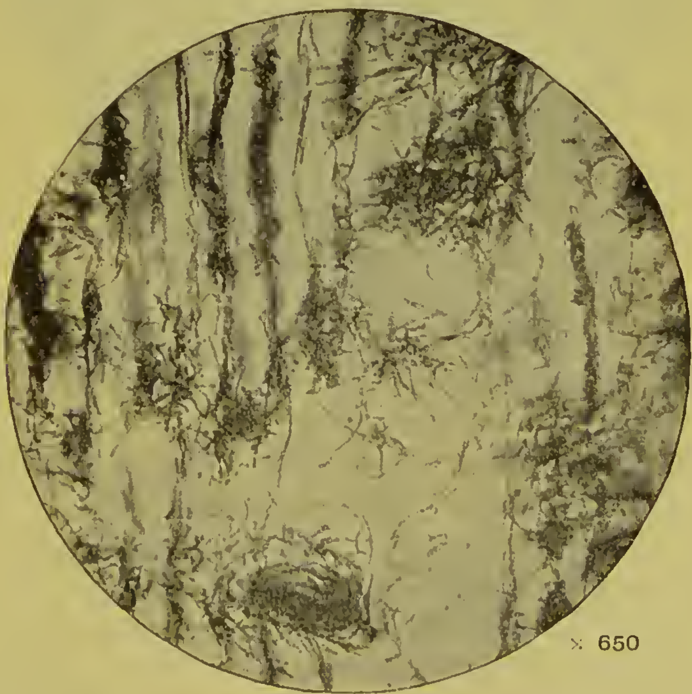


Fig. 337.—Longitudinal section of carious dentine, showing tubes filled with leptothrix. Photo-micrograph by Mr. J. Howard Mummery.

dentine matrix has disappeared and micro-organisms have taken its place. These globular masses have been termed "liquefaction foci."

(iv.) The irregular masses are formed by the fusion of "liquefaction foci."

FIG. 338.—Carious dentine, showing that laterally the boundary between the infected and non-infected parts may be very regular (Miller).

In sections containing interglobular spaces, the latter are generally seen to be filled with masses of organisms, although occasionally the interglobular spaces appear to be quite free from infection. Figs. 334 to 337 are longitudinal sections through carious dentine stained to demonstrate the micro-organisms.

That the softening precedes the infection can be shown by sections of carious dentine which have been stained to demonstrate the micro-organisms only. From an examination of such a section

it will be apparent that the portion towards the cavity is stained and that towards the healthy dentine unstained, thus proving that **the softening precedes the infection.** Miller has termed the unstained portion the "**non-infected zone.**" The micro-organisms have a greater tendency to spread in a direction towards the pulp than laterally, though where a large number of interglobular spaces are present such is not always the case. The line between the infected and the non-infected zones is often well marked (fig. 338), and though the majority of tubes near the surface are infected, this is not noticeable in the deeper parts. Near the margin leptothrix is mainly found, while the tubes are generally filled with micrococci or simple bacilli.

Fig. 339.—Row of shining granules in the tubules, from a tooth used as an artificial substitute (Miller).

The infection is often of a mixed character.—Micrococci and bacilli are usually present and generally in separate tubules, but a mixed infection may be present in an individual tubule.

In addition to micro-organisms *rod-shaped fragments or elements can usually be demonstrated in the tubules* and are also seen in artificially-produced caries. These elements, the source of which

is not definitely known, have been supposed to be either (i.) portions of consolidated fibrils; (ii.) pieces of the sheaths of Neumann; or (iii.) casts of the enlarged fibrils. Miller finds that when brought into contact with inorganic acids (dilute sulphuric acid) the elements immediately disappear, but when organic acids are used these elements become more distinct, and he therefore thinks that they are probably lime formations. *Rows of shining irregular granules* are also met with, generally in the zone, in advance of the caries (fig. 339). It is possible that they have the same origin as the rod-shaped elements, for, if the latter be crushed, granules can be produced.

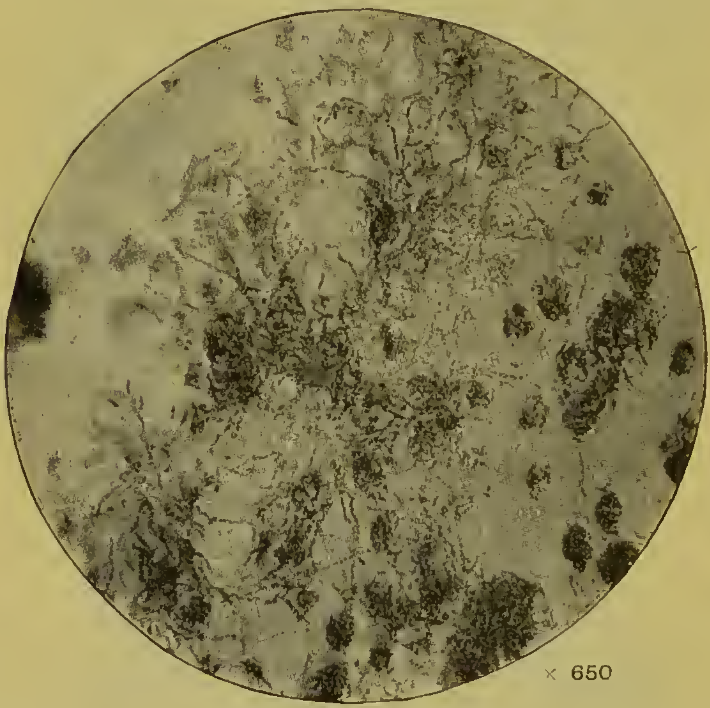


FIG. 340.—Transverse section of carious dentine, showing enlarged tubes filled with micro-organisms, principally leptothrix forms.

Transverse sections near the cavity show the tubes enlarged and filled with micro-organisms, fig. 340. In transverse sections taken nearer to the normal dentine it is found that the sheath of the dentinal tubes is considerably enlarged, this being probably due to decalcification. The appearance of the dentine thus produced has been termed the *tobacco-pipe* appearance (Tomes). This is shown in fig. 341.

This appearance is also seen in caries occurring in teeth used as substitutes, and in caries produced by artificial means.

In the *Trans. Odonto. Soc.* for 1892, Mr. Tomes has figured a tooth found in the graveyard of an old church. The cementum and dentine of this tooth have been bored in many directions by a fungus, probably the Saccharomyces mycoderma (Miller). The penetration of the dentine by Saccharomyces mycoderma is, according to Miller, frequently seen in teeth used as artificial substitutes. It is not at all improbable that other fungi may possess the power of penetrating dentine.[1]

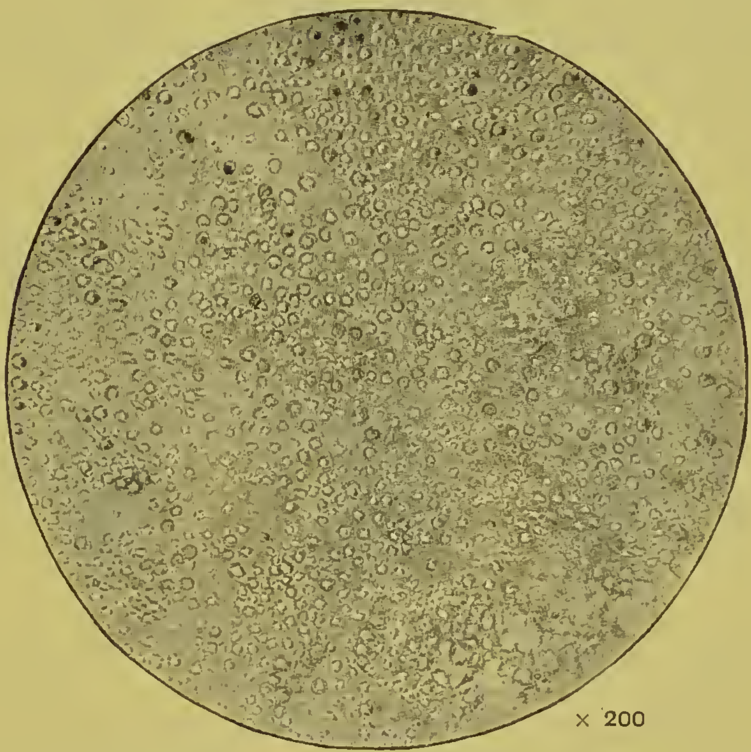


FIG. 341.—Photo-micrograph by Mr. A. Pringle.

An account of the various bacteria concerned in the carious process will be found on pages 228 to 235.

(*c*) **Cementum.**—Caries of cementum resembles in some details that of dentine, especially when the micro-organisms penetrate, as they commonly do, along the lines of Sharpey's fibres. The destruc-

[1] *Trans. Odonto. Soc.*, vol. xxviii., p. 37.

tion of the decalcified tissue takes place in exactly the same way as in caries of the dentine.

(*d*) **The effect of caries upon the pulp.**—This portion of the subject will be referred to in detail when dealing with the pathology of the dental pulp.

(D) SPONTANEOUS ARREST OF CARIES.

From some cause or causes at present unexplained, caries, at times, is spontaneously arrested. This condition may occur in any of the teeth, but is most frequently met with in the first permanent molar. The teeth affected are generally hypoplastic teeth which have been attacked by a superficial caries; the enamel of the masticating surface and even of the sides may have been destroyed, the dentine being left intact but discoloured. In such cases the dentine will be quite soft to the probe as long as the caries proceeds, but when the disease has been arrested the dentine will become as hard, if not harder, than normal. Patients in whom this change takes place have nearly always undergone some marked improve-

FIG. 342.—Teeth showing arrested decay.

ment in health, and in a case under notice, a patient who presented himself with practically all his back teeth in an advanced condition of caries was recommended to have them removed; this was not done, and subsequently he went for a long sea-voyage; on returning after a lapse of one year the caries was found to have undergone spontaneous arrest. Microscopical examination shows that the dentine retains the colour of carious dentine, or is perhaps rather darker. The surface is irregular, the dentinal tubes, which can easily be seen in the discoloured part, apparently ending abruptly on the surface.

In the four sections examined staining had failed to show any

micro-organisms except at those spots where caries was recommencing. A section of such a tooth is shown in fig. 343.

It is difficult to see exactly what can bring about the arrest. General improvement in health is no doubt an important factor, and indirectly improving the local conditions existing in the mouth prevents the development of acids and the growth of bacteria, but how the hardening of the softened dentine is brought about is a more obscure problem. Some have assumed the hardening to be the result of dehydration of the dentine, but this seems improbable when it is recollected that the teeth are constantly bathed in moisture. It seems far more likely that it is due to some vital action on the part of the tooth, and it would therefore be interesting to note if the condition is ever seen in caries proceeding in pulpless teeth.

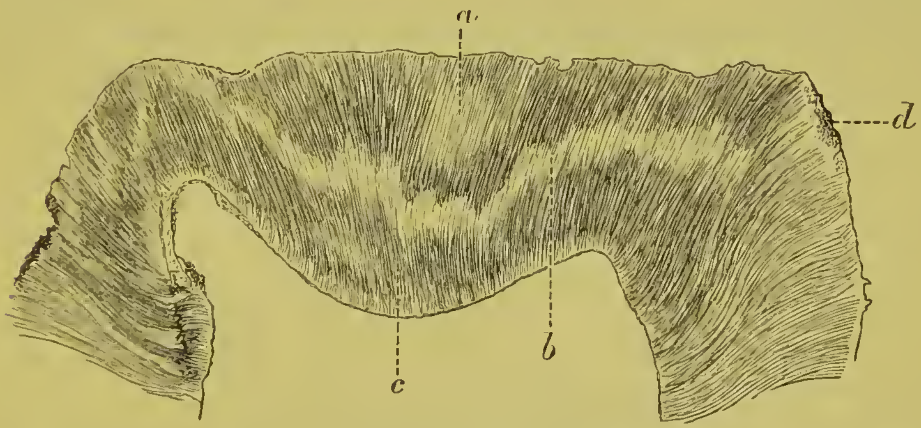


FIG. 343.—(*a*) Portion of dentine in which the decay has become arrested; (*b*) translucent zone; (*c*) normal dentine; (*d*) a softened patch of dentine showing micro-organisms.

(E) EXPERIMENTAL REPRODUCTION OF CARIES.

The production of caries in teeth artificially was first successfully accomplished by Miller. Teeth which were perfectly sound, but of different density, were cut into pieces of different sizes and placed in a mixture of saliva, meat and bread. This mixture was kept for three months at 98° F., and during the course of the experiment repeatedly renewed. In artificial caries translucency is absent, but translucency probably forms no essential part of the carious process, as it is found in other pathological conditions in the

mouth. If the reaction of the solution in which the teeth are placed becomes alkaline, or if the teeth are exposed to the air or to the action of different articles of food, such as coffee, tea, tobacco, fruit, &c., all possible shades of colour are produced similar to those found in the mouth (Miller.)

The following method is suggested by Mr. Hopewell Smith:[1] "Sound teeth, whole or in part, are placed in a mixture of mixed human saliva, a small quantity of glucose, and a fragment of bread and uncooked meat. The teeth are first washed in saline solution. If they possess marked pits or fissures, so much the better. The roots of two or three may be covered with a film of collodion, or the whole teeth may be enveloped in this film, and spots, laying bare the hard tissues, made in places. The mixture is contained in a sterilised Erlenmeyer's flask—a fairly large one, half a litre, is useful. About four ounces of the fluid is the right proportion for four teeth. On testing the mixture it may be found to be faintly alkaline or neutral. Into the mouth of the flask there is placed a sterilised wool plug, and a sterilised caoutchouc cap fitted over it. The whole is placed in an incubator at 37° C.

"Examined at the end of twenty-four hours the mixture will be found to be slightly acid. This acidity is marked at the end of forty-eight hours, and not until the lapse of several weeks are there any signs of the fluid becoming again alkaline.

"In five days, as already stated, the enamel becomes disorganised, and cover-glass films can be made. At the end of seven or eight weeks the teeth should be removed and broken into small fragments, the film of collodion being, of course, removed. The fragments are decalcified in a 10 per cent. solution of hydrochloric acid, then neutralised, washed, imbedded in gum mucilage, and cut on a microtome. The very thinnest sections are to be stained, after well washing, by Gram's method, or in any other way, as the fancy of the student may dictate. In this manner, then, the periphery of the hard parts of the teeth becomes carious.

"In order to obtain further disintegration, the teeth should be washed and placed in a fresh mixture under like conditions. Ultimately 'liquefaction foci' and the formation of cavities, to a limited extent, occur, the process being identical with caries produced naturally, and the resulting microscopical specimens differing

[1] "Dental Microscopy," second edition, p. 170.

in no particular when similar methods of staining have been pursued."

It is questionable if the sterilisation precautions suggested by Mr. Hopewell Smith are at all essential to the process, since all the materials used in the production of artificial caries contain various kinds of organisms. Such precautions are only necessary when experimenting with pure cultures.

M. Choquet has recorded[1] an interesting experiment in which he submitted normal dentine to the action of a pure culture of a micro-organism. From three carious teeth which had been filled he isolated five species of micro-organisms. Of one of these he obtained a pure culture and applied it to a small cavity drilled in the incisor of a sheep, the culture being retained in position for nine months. The dentine at the end of this period was found to have undergone certain changes, namely, softening and alteration in colour. The appearances, however, were in no way typical of carious dentine. The experiment is interesting, but it can hardly be claimed that artificial caries was produced.

(F) ETIOLOGY.

The causes of caries may be divided into two groups :—

(1) Exciting.

(2) Predisposing.

(1) EXCITING CAUSES.

Miller says, in his work on "Micro-organisms of the Mouth," that "*dental decay is a chemico-parasitical process consisting of two distinctly marked stages*—decalcification or softening of the tissue and dissolution of the softened residue. In the case of enamel, however, the second stage is practically wanting." The principal acid formed is lactic, from amylaceous and saccharine substances which lodge in suitable centres and undergo fermentation. In the case of sugars, those belonging to the grape-sugar group, namely, dextrose, levulose, galactose and maltose, are directly fermentable according to the equation—

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[1] International Medical Congress, Paris, 1900, reported *Brit. Journ. Dental Science*, November 15, 1900.

$$C_6H_{12}O_6 = 2\ C_3H_6O_3$$

Cane sugar and milk sugar are only fermentable after hydrarisation—

$$\underset{\text{(Cane Sugar)}}{C_{12}H_{22}O_{11}} + H_2O = \underset{\text{(Dextrose)}}{C_6H_{12}O_6} + \underset{\text{(Levulose)}}{C_6H_{12}O_6}$$

The dextrose and levulose are then acted on by the lactic acid ferment.

In the case of starch the ptyaline transforms the starch into grape sugar, which is then directly fermentable.

Experiments have proved that when fermentable albuminous materials are combined with saliva little acid is formed, which soon disappears; while, when the putrefaction of albuminous substances, such as meat, takes place in the mouth, acids are formed, but they are more than neutralised by the various alkaline products which appear, so that the reaction of the medium is distinctly alkaline. Raw vegetable food is less prone to fermentation than when cooked.

When once decalcification by means of the acids has taken place, the remaining organic portion of the tooth substance is dissolved by the action of bacteria, which perform their work by acting upon the dentine in much the same way as the pepsin of the gastric juice acts upon albuminous materials.

In describing the microscopical phenomena of carious enamel the constant presence of a felt-like mass of micro-organisms on the surface of the tooth was referred to. Leon Williams states, "This mass of fungi is so dense and adhesive as to make it highly improbable that the enamel is affected, except in rare or special instances, by any acid other than that which is being excreted by the bacteria at the very point where they are attached to the enamel." This felt-like mass, however, is present in enamel not undergoing caries, for Williams states, "further experience has convinced me that the cases in which the approximal surfaces are not covered by a thick, felt-like and glutinous mass of micro-organisms are very rare. In fact, since I devised a simple means of grinding thin sections of enamel without disturbing any bacteria which might be present on the surface, I have not once failed to find them on the approximal surfaces of the teeth." The fact, then, that these masses are not special to carious enamel, and that the carious process nearly always starts in places where *débris* of food, &c., collect, would tend to support Miller's view as to the source of the acid.

Black would seem to hold a similar view to Williams, for he

states, "Caries of teeth has its beginning only when the conditions of the oral secretions are such that the micro-organisms causing caries form gelatinous plaques, by which they are glued to the surfaces of the teeth."

The view advanced by Miller of the direct causation of dental caries is usually known as the "chemico-parasitic." In support of it we have the facts that in caries micro-organisms are always present, and the liquefaction foci producing the cavern-like spaces are not found if bacteria are absent. In teeth acted upon solely by acids only a softening of the tissues takes place, and there is no approach to real caries; while if a tooth be artificially exposed to both germs and acids, caries is produced in every respect resembling the ordinary disease. The principal argument advanced against this view is that one would expect to find caries progressing in teeth containing putrid pulps. The argument is, however, unsound for the following reasons :—

(i.) Bacteria either perish or become inactive in putrid pulps.

(ii.) There is no carbo-hydrate material in pulps, and this material is necessary for the formation of acids. A putrid pulp is nearly always alkaline in its reaction, and the alkalinity necessarily checks the action of the micro-organisms.

Various other theories have been advanced to account for the phenomena of caries. **The inflammatory** theory has received the support of Abbot, Heitzmann and Bödecker. They assume the presence of inflammation, and maintain that actual inflammation takes place even in the dentine. Many strong arguments can be urged against this view. The microscopical appearances which these observers have used to support their theory are in reality caused by masses of micro-organisms.

The **electrical** theory advanced by Bridgeman. He holds that the crown of the tooth forms one pole and the root the other, the electrolyte being the saliva. In abnormal conditions of the saliva electrical action takes place, resulting in the abstraction of lime salts from the positive pole by the action of acids in the saliva.

The **chemical** theory supposes caries to be due solely to the action of acids. The first stage of caries is admitted to be the result of acid action only, but it is impossible to produce caries in dentine without the presence of micro-organisms, the action of the acid merely resulting in a decalcified framework of the tooth.

The **parasitic** theory. The best exponents of this theory in

recent years have been Milles and Underwood, who ascribed all the phenomena of caries to micro-organisms; to use their words, "two factors have always been in operation:—

"(i.) The action of acids.

"(ii.) The action of germs.

"Most probably the work of decalcification is entirely performed by the action of acids, but these acids are, we think, secreted by the germs themselves, and the organic fibrils upon which the organisms feed, and in which they multiply, are the scene of the manufacture of their characteristic acids, which in turn decalcify the matrix and discolour the whole mass."

It will be seen that according to Milles and Underwood the acid is produced by the putrefaction of the albuminous contents of the dental canaliculi; whereas, according to Miller, the acid is produced by the action of bacteria upon the carbo-hydrates used as food. We have already seen that albuminous substances undergoing putrefaction give rise to an alkaline reaction.

(2) PREDISPOSING CAUSES.

(*a*) **Local.—(i.) Connected with the tooth.**

(α) **Form and structure.**—In this connection there are two groups of observations to which attention must be drawn. Leon Williams, in his paper "The Pathology of Enamel," has found that defects in structure such as pits, grooves, fissures, pigmentations, granular and amorphous enamel are often found in the lower animals, whose teeth we know are comparatively free from caries. He says, "We may frequently find enamel of a markedly imperfect structure which has run the gauntlet of time for fifty or sixty years and is free from decay. We frequently find enamel decaying rapidly, which from every test that can be applied to it seems perfect in structure and composition." He does not, however, give any statistics to show what proportion of such defective teeth are attacked by caries, or in what ratio caries in these defective teeth stands in regard to caries in teeth apparently of normal structure.

The researches of Dr. Black[1] and Mr. Tomes[2] have shown that the hitherto supposed deficiency in lime salts of teeth, clinically

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[1] *Cosmos*, 1895. [2] *Journ. Brit. Dent. Assoc.*, October, 1895.

known as soft, does not exist, and that the molars contain more inorganic material than the incisors. Mr. Tomes' figures are as follows:—

Incisors: 71·2 per cent. inorganic salts.
28·8 per cent. organic and water combined.

Molars: 73 per cent. inorganic salts.
27 per cent. organic matter and water in combination.

Dr. Black's figures, reduced to percentage of dry dentine, give 71·7 for incisors and 72·3 for molars.

In one interesting examination made by Mr. Tomes of a set of teeth in which the third molars were barely in place, the two premolars being largely affected by caries, and incipient decay existing between many of the teeth, an analysis gave 71·4 per cent. of salts, whilst another dentition much worn by attrition, but quite free from caries, gave 71·4 per cent. in both, therefore, the percentage of salts was below the general average. A point brought out by Mr. Tomes is the presence in the dentine, and also probably in the enamel, of water in chemical combination. The investigations of Black and Tomes are suggestive, but they are by no means conclusive. The analyses are quantitative and not qualitative, and therefore do not bring out the varying proportions of the different salts. Moreover, the main difference between teeth which are chemically known as "hard" and "soft" may be after all in the enamel. Some have assumed that this is improbable because the enamel contains practically no inorganic matter, but, as pointed out in connection with the dentine, marked differences may exist in the amount of water chemically combined and the proportion of the various salts. Until these proportions are determined we certainly are not justified in assuming that teeth do not differ in hardness. It is difficult to believe that the bluish translucent enamel and the dense yellowish enamel are identical in structure. The researches enumerated do not by any means conclusively prove that there are no characteristics in the tooth structure which give teeth different powers of resistance. That teeth do possess different powers of resistance seems more than probable, the tendencies seen in certain families for caries to start in particular teeth strongly supporting this view. Black[1] gives some interesting examples. In certain

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[1] "Susceptibility and Immunity to Dental Caries," *Cosmos*, September, 1899, p. 820.

families under his care the first cavities in parents, children and grandchildren were in the approximal surfaces of the maxillary incisors. He gives an instance where the first caries in the three generations appeared on the approximal surfaces of the upper premolars between the ages of 16 to 18.

Similar instances have been noticed by many practitioners. It would thus appear that in these cases there was hereditary predisposition to caries in certain teeth. Until, therefore, more conclusive evidence is forthcoming to the contrary, we must consider from clinical experience that defects in the form of the tooth such as pits, fissures, &c., and variations in the structure of a tooth do act as important predisposing causes.

(β) **The relation of one tooth to another** is an important factor in rendering teeth liable to attack. When the teeth are in a regular position the tongue and lips and such artificial means as the tooth-brush, silk and tooth-pick are easily able to keep the surfaces clean; but when placed irregularly, crevices are formed which are inaccessible. Again, the teeth, when normally placed, only just touch one another, and the space at the necks is occupied by gum which prevents the lodgment of food. Anything, therefore, which alters this condition, such as the loosening and recession of the gum, will act as a predisposing cause.

(ii.) **External causes.**

(α) **Abnormal condition of the secretions of the mouth.**—Investigators have paid but little attention to this subject, but it seems more than likely that a study of the saliva in disease will assist the elucidation of the pathology of caries. In patients suffering from certain types of dyspepsia accompanied by pyrosis, the saliva is often acid in reaction, and caries of the enamel of a diffused type is at times seen. Conditions in which the saliva becomes more mucoid than normal predispose to caries because very mucoid saliva clings more easily to the teeth, especially at the necks, and so assists in the lodgment of food *débris*. This mucoid condition of the saliva is frequently seen in many febrile conditions and is brought about more by the arrested secretion of the other elements of the saliva than by an excessive secretion of the mucus.

(β) **The class of food** exerts an influence in proportion to its liability to undergo fermentation. For example, it is found that meat-eating tribes are practically free from caries, while in those whose staple food is carbo-hydrates such is not the case. The

chemical composition exerts its influence, and the effect on the teeth of such liquids as cider is well known.

Mr. Sim Wallace[1] states that he has made about 600 experiments with a view of ascertaining the food stuffs which are more apt to lodge. His experiments lead him to believe that the food stuffs from which the fibrous elements have been removed are much more likely to lodge than those containing the fibrous element.

(*b*) **General.**—(i.) **Hereditary influence** is denied by certain observers, but from clinical experience heredity must be regarded as a predisposing cause. The cases cited by Black and others support the view that hereditary weakness is transmitted to certain teeth; on the other hand it is quite possible that the tendency to caries in some families is increased by similarity of environment, including food, habits, &c.

(ii.) **Pregnancy.**—During the period of pregnancy many women seem more liable to caries. An explanation must probably be looked for in some change of the oral secretions, which furnish a more favourable soil for the development of micro-organisms. It is possible that the vomiting of pregnancy may to some extent aid the development of caries. This predisposition of the pregnant to caries is by no means constant, and in practice one meets with many instances of women with large families who have excellent teeth, and who show no increased liability to caries during the pregnant period.

(iii.) **Certain occupations.**—Millers and bakers are especially liable to caries. In alkali workers, who are exposed to the fumes of acid during the process of manufacture, the teeth are said to become blackened and rot away.

(G) THE CAUSE OF THE GREAT PREVALENCE OF CARIES.

Many theories have been advanced to account for the rapid increase of caries during recent years. In endeavouring to ascertain the cause it may be interesting and instructive to remember that the teeth have not alone suffered, marked deterioration having taken place in other organs, as evidenced by the increase of defective

[1] "The Cause and Prevention of Decay in Teeth."

eyesight and tendency to hypertrophy of adenoid tissue in the naso-pharynx. Moreover, the present generation seem to have had their power of resistance to morbid conditions much reduced, and these defects are still more marked in the rising generation. These facts seem to indicate that the cause should be sought for in some general rather than purely local condition.

In the investigation of Röse, already referred to, one important fact is brought to light, namely, the marked "influence on caries of lime" in the food and water. His figures speak for themselves. They are as follows:—

		Per cent. of Children with Caries.		Per cent. of all Diseased Teeth.
(1) Country Places Poor in Lime.				
In Baden	...	98·7	...	35·3
In Thuringia	...	92	...	34·9
(2) Country Places Rich in Lime.				
In Baden	...	79	...	16·1
In Thuringia	...	82·8	...	16·7

In two villages, Guntersthal and Uffhausen, distant only about three kilometres as the crow flies, he found a remarkable difference. The former, where the formation is gneiss and the water 1·7 to 2·8 degrees of hardness (German calculation), in 118 children 34·6 per cent. of the teeth were carious, while at Uffhausen, where a Jura-lime formation exists, the water was 14 to 19 per cent. of hardness, and in 162 children the percentage of teeth carious was 20·7.

The manner in which food is prepared in modern communities may influence the development of caries. Mr. Sim Wallace goes so far as to state that "the cause of the prevalence of dental caries is that the natural food stuffs are to a large extent ridded of their accompanying fibrous parts, and prepared and consumed in a manner which renders them liable to lodge and undergo acid fermentation in the mouth, while from the same cause and the induced condition the micro-organisms of the mouth lodge and multiply and augment the rapidity and intensity of the acid fermentation."

It would be interesting to discover how far the elimination of the fibrous elements from our food stuffs deprives them of their lime salts.

In the case of wheat there are reasons to believe that in the process of milling a large percentage of the lime salts is lost. With modern cooking the first act of deglutition is considerably reduced in character, and the slight use required of the muscles of mastication indirectly robs the teeth and gums of a nourishing blood supply.

Dr. Kingston Barton (*Medical Press*), as a result of twenty years of observation, is strongly impressed with the "**influence of infant feeding**" on the teeth. He finds that breast-fed children have the best teeth, those fed on cows', asses', or goats' milk come off next best, but when starch or any patent food is added to or given in place of cows' milk, the teeth, both deciduous and permanent, almost always turn out badly.

"**Modern civilisation," with its incessant rush and unhygienic habits of life**, tends to lower the general vitality of the human organism, but the discussion of this hardly falls within the scope of this work.

Recapitulation.—The process of caries may be concisely described as follows. The form and relative positions of the human teeth favour the lodgment of food stuffs upon or between them. Of the three groups of food stuffs, the nitrogenous food, the carbohydrates, and the fats, the second group is particularly concerned in bringing about the process of caries.

Of the three groups of carbo-hydrates, cellulose, starch and sugar, it is doubtful whether the first (cellulose) undergoes any change in the mouth which gives rise to products injurious to the teeth, whereas starch is first converted into dextrose by the action of the ptyalin of the saliva, and the dextrose through the agency of micro-organisms (fermentation) into lactic acid, and, possibly, other organic acids in minute quantities. The sugars, when directly fermentable, are by the same process converted into acids, whereas those not directly fermentable, *i.e.*, cane sugar, take up a molecule of water under the action of invertin (a ferment produced by many bacteria), and are then split up into dextrose and levulose, both of which are directly fermentable, producing lactic acid in the presence of many mouth bacteria.

These acids, from whatever source produced, attack the teeth at the point where they are generated, that is, wherever the foods in question have lodged on or between the teeth, and lead to decalcification, first of the enamel (or cementum), and later of the dentine. The decalcification of the enamel results in its complete destruction, as the organic substance in the enamel is insufficient

to hold together after decalcification, whereas decalcification of the dentine does not signify the complete destruction of the organic basis, as this remains in the form of the so-called tooth cartilage. This organic basis being of a nitrogenous nature, undergoes decomposition in very much the same way as all other nitrogenous substances exposed to the action of bacteria in the presence of moisture and a suitable temperature. The agent which brings about this decomposition is a ferment produced by many of the bacteria of the mouth, and acts in very much the same way as the pepsine of the gastric juice, except that it does not require the presence of acid. Very little is known as to what changes of a fermentative nature take place in the fats in the mouth; it is possible that a fermentation may occur leading to the formation of fatty acids, but if so, the quantity produced is so minute that it has not as yet been detected.

FOOD STUFFS.

- Proteids (nitrogenous foods) — Their decomposition by bacteria gives rise to a large number of different products resulting in an alkaline reaction.
- Carbohydrates
  - Cellulose — The action of bacteria on this substance in the mouth (probably but slight) has not been determined.
  - Starch — Acted upon by ptyalin produces — Dextrose or maltose; Dextrine[1] — Acted upon by bacteria produces — Lactic acid (and traces of other acids).
  - Sugar
    - Fermentable — Acted upon by bacteria produces — Lactic acid (and traces of other acids).
    - Non-fermentable — Converted into fermentable sugar by a hydrolitic ferment contained in many bacteria, *e.g.*, $C_{12}H_{22}O_{11} + H_2O$ (Cane Sugar) $= C_6H_{12}O_6 + C_6H_{12}O_6$ (Dextrose) (Levulose) — Acted upon by bacteria produces — Lactic acid (and traces of other acids).
- Fats — ? Fermentation in the mouth may result in traces of fatty acids, but so far undetected.

[1] Regarding the action of mouth bacteria on dextrine very little is known.

Nitrogenous substances, as already explained above, undergo very active decomposition in the mouth, resulting, however, not in an acid, but in an alkaline reaction ; an excess of nitrogenous food, for example, a diet consisting chiefly of meat, might serve to arrest the process of decay, inasmuch as the acids produced in the mouth by the fermentation of carbo-hydrates would be in part, or completely, neutralised by the alkaline products arising from the fermentation of nitrogenous food.

The table on the previous page, suggested by Mr. Mummery and Dr. Miller, shows the part that the different classes of food stuffs play in the production of caries.

(H) SYMPTOMS.

Pain in the region of the affected tooth may occur. If the caries is on a surface free to the tongue the patient will be conscious of a cavity. In many instances the lodgment of food between the teeth is the first symptom noticed. The pain is due to irritation of the pulp *viâ* the dental fibrils, and will vary according to the situation and extent of the cavity. On occluding surfaces, the fibrils being exposed, changes of temperature or the introduction of irritant substances into the cavity will produce pain which increases in severity as the cavity becomes larger. In cavities tucked away under the gum or on approximal surfaces pain is often not felt until the pulp is involved. The extent of pain varies in different temperaments, and in the same individual at different periods. Patients of a nervous temperament suffer more than those of a lymphatic temperament. In a few patients caries gives rise to no pain.

CHAPTER VIII.

The Treatment of Caries.

The treatment of caries may be divided into—
(A) Prophylactic.
(B) Remedial.

(A) PROPHYLACTIC.

A large amount of caries may be prevented by careful attention to the hygiene of the mouth. The teeth should be cleansed every morning and night, and if possible after each meal. Acids and bacteria are the exciting causes of decay, and it therefore follows that any tooth powders or mouth washes used should contain both antacids and antiseptics. The tooth-brush used should be small, and should contain fewer bristles than the ordinary tooth-brushes sold; the bristles should be of different lengths, as this will permit them to pass more easily into the interstices of the teeth. The brush should be used with an upward and downward movement, *i.e.*, in the direction of the long axes of the teeth, or with a circular motion. Not only should the outside of the teeth be cleansed, but also the masticating surface and the lingual surface. In addition to the brushes, silk dipped in some antiseptic lotion should be passed regularly between the teeth, as by this means decay on the approximal surfaces will be, to a great extent, prevented.

A prophylactic measure which seems to yield good results is as follows:—

℞	Magnesiæ carbonatis	ʒss.
	Aquæ rosæ	℥iij.

Misce. Shake before using.

Every night and morning after cleansing the teeth, a teaspoonful of the above should be taken into the mouth and sluiced about between the teeth. The magnesia, being an alkali, counteracts acidity.

In cases of acute fevers, or any condition where the patients are helpless, their teeth should be cleaned by the attendants, and the same applies to children. All foods which are specially liable to ferment and produce acids, or which may be acids themselves, should be avoided; or, if taken, the mouth should be well rinsed afterwards with some alkaline and antiseptic solution. If the anterior teeth are crowded some of the posterior teeth should be extracted (see chapter iv., section F.). This will allow the anterior teeth to separate so that they can be kept cleaner and the approximal surfaces more easily filled—points of much importance.

Patients wearing artificial dentures should be instructed to keep all clasps, &c., quite free from food, and all dentures should be cleansed after every meal. The surfaces of the teeth which come in contact with the dentures should be cleaned with silk or lint, as the food which collects in this region is a frequent cause of caries.

A crow-quill toothpick, in the majority of cases, may be used with advantage, as by this means *débris* of food is removed and fermentation prevented.

The following prescriptions for tooth-powders, mouth-washes, &c., are suggested:—

TOOTH POWDER.

℞	Saponis hisp.	ʒij.
	Pulv. iridis	ʒiij.
	Os. sepiæ pulv.	ʒij.
	Cretæ præcip. } Magnes. carb. pond. }	āā ʒij.
	Ol. eucalypti	♏viij.
	Otto rosæ	♏viij.

FLUID DENTIFRICE.

Tincture of Quillaia with 1 p.c. of Benzoic Acid.

Several varieties of soap dentifrices are made, of which those manufactured by Messrs. Bell and Co., of Oxford Street, and by Messrs. Cook, are reliable.

MOUTH WASHES.

℞	Tinct. calendulæ	℥j.
	Aquam ad	℥viij.

The following formula is recommended by Miller:—

℞	Thymol	gr. iij.
	Acidi benzoic	gr. xlv.
	Tinct. eucalypti	℥ss.
	Olei Gaultheriæ	gr. xxv.
	Spirit. rectificat.	℥iv.

To this mercuric chloride gr. vij. may be added if desired.

ANTISEPTIC (FOR DIPPING SILK).

Mercuric chloride in absolute alcohol .. 1 in 1000.

(B) REMEDIAL.

The remedial treatment may be considered under—

(1) The operation of filling.
(2) The operation of excision.
(3) The use of drugs.
(4) The adaptation of artificial crowns.
(5) The operation of extraction.

THE OPERATION OF FILLING.

(*a*) The Exclusion of Saliva.

The exclusion of the saliva during the operation of filling is necessary. There are several methods by which this may be accomplished.

(i.) **The rubber dam** is by far the best method of excluding saliva. Some practice, however, is required before it can be quickly and accurately applied. In the choice of rubber several points have to be taken into consideration. Elasticity, extensibility, and freedom from smell are essential properties of good rubber. A medium thickness of rubber is best for general purposes.

Various methods are in vogue for *perforating the rubber dam.* The first and simplest is to stretch the dam over the end of an excavator, and then to touch it a short distance from the extremity of the instrument with a penknife, when a small round disc will fly off; a little practice will soon enable the operator to control the size of the perforation. Another method is to fold a piece of rubber into four, so that the point of folding coincides with the position of the required perforation, and to cut off the corner with a small pair of scissors. By this means a hole is cut which, although not truly circular, is sufficiently so for the purpose required. Lastly, perforations may be made with punches specially manufactured for the purpose—this is the best method.

In applying the rubber dam to back teeth a little trouble is at first experienced in gauging the correct position to punch the hole. This difficulty may be readily overcome by placing the rubber in the mouth, and marking roughly where it comes over the tooth or teeth to be encircled. With molars the holes should be about $\frac{3}{32}$ inch apart from one another. In dealing with simple crown cavities the rubber may be adapted to the single tooth, but with an approxi-

mal cavity the application must be extended to the tooth adjacent to the cavity. In applying the rubber dam it is most important that it should be tucked under the edge of the gum, as this prevents the rubber slipping, and also checks the saliva from dribbling down between the rubber and the tooth. The accompanying diagrams illustrate this point.

The drawings represent an antero-posterior section of an incisor. In figs. 344 to 346 is shown the method of tucking the rubber dam under the edge of the attachment of the gum to the neck of the tooth. In fig. 345 is shown the manner in which the rubber is applied when this precaution is not taken; and fig. 346 represents the rubber as correctly applied.

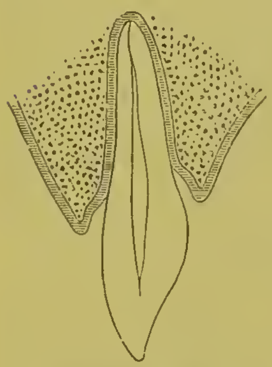


FIG. 344.—Showing attachment of gum to tooth.

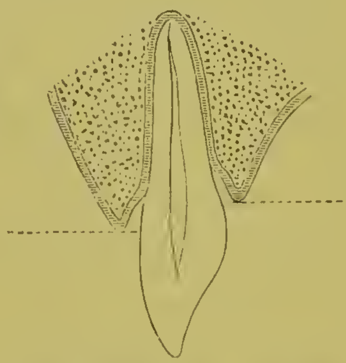


FIG. 345.—Showing position of rubber dam when not tucked under the edge of the gum.

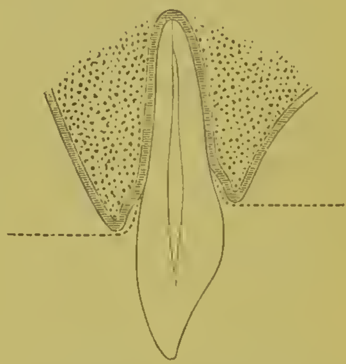


FIG. 346.—Showing position of rubber dam when tucked under the edge of the gum.

The rubber should be tucked in with a blunt instrument, such as a burnisher, or silk may be passed between the teeth. The former is sometimes quite sufficient, but generally the latter has to be employed.

Clamps are useful to assist in keeping the rubber in place. The "festooned" molar and premolar introduced by Dr. Tees, and the clamps designed by Dr. Delos Palmer are good patterns. Dr. Palmer's clamps are admirably adapted for fitting the teeth, but there is one objection to them, the flanges are hardly broad enough to always prevent the rubber slipping over them.

In applying rubber dam to teeth having approximal cavities it is important that the cervical edge of the cavity should be well defined; if the gum has encroached at this point it will be necessary

to press it back or destroy it by means of "potassa cum calce" or "ethylate of sodium" applied on cotton wool, assisted by gentle pressure. Sharp edges are sometimes met with, and are a source of great inconvenience when passing the silk; these should be removed, if possible, before the application of the rubber is commenced. Lastly, any deposit on the teeth should be removed before applying the rubber dam.

Application to front teeth.—This can be accomplished in the following manner:—

Take a piece of rubber of the necessary size and pierce the number of holes required, taking special precaution to have sufficient space between them. As a general rule it will be found advisable to include at least four teeth under the rubber. For example, in the case of a cavity on the mesial surface of the right central incisor the rubber should include the four incisors. With a cavity on the distal surface of the right lateral incisor, the application should be made to the first premolar, the canine and the right lateral and central incisors. Holding the rubber between the finger and thumb of both hands, stretch it over the required teeth, commencing at one end and passing it over the remainder in order.

Should the teeth lie close together, a little difficulty may be experienced in passing the rubber between them. This may be best overcome by drawing a strand of silk between the teeth, which will carry the rubber dam before it. If silk will not pass, a separation must first be made. This operation completed, apply the retractors and should the rubber not lie easily over the lower lip, attach weights to either corner. A napkin should be placed under the rubber and brought under the retractors. This, with the use of the saliva ejector, will mitigate some of the inconvenience to the patient. The next step is to **pass the silk** in order to "tuck the dam under the edge of the gum" as already explained. An easy, quick and effective method of doing this is as follows, and a reference to the accompanying diagrams will greatly assist in following the description:—It is supposed that there is a cavity on the distal side of the left central. First, take the silk between the thumb and first finger of the right hand and the thumb and first finger of the left, and pass it up between the centrals, leaving it there; repeat the same on the side approximal to the lateral, having the free ends of silk in front and the loop behind. Next take the free ends between the thumb and first

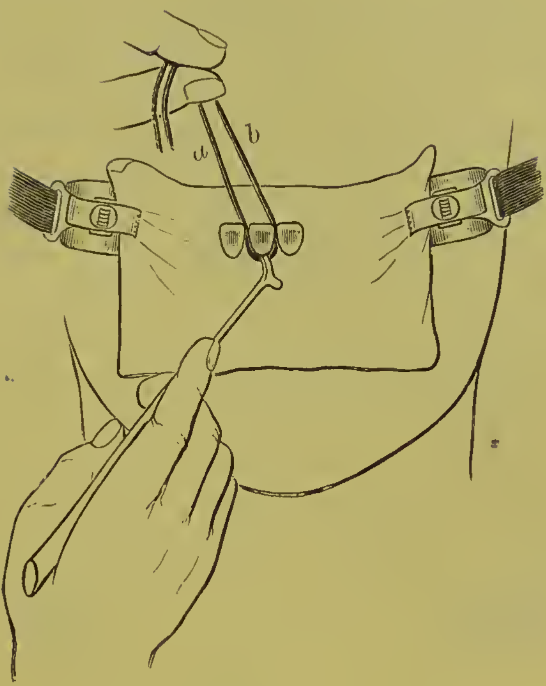


FIG. 347.

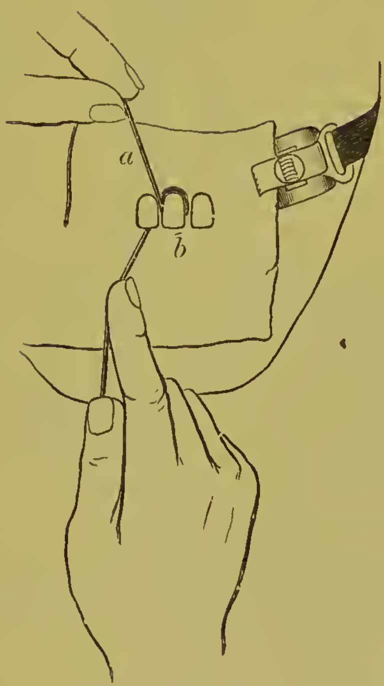


FIG. 348.

finger of the left hand and draw them well forward; at the same time, by means of a burnisher, guide the loop over the cingulum and above the free edge of enamel, still pulling the ends well forward (fig. 347). Hold the end *a* in the left hand in a direction slightly upwards and pass the end *b* over it, and then, still holding *a* as described, bring *b* between the centrals, using traction in a direction downwards and backwards (fig. 348). Then either cut the ends off short and leave the silk in position or remove it altogether. The former is preferable. The silk should be applied to every tooth over which the rubber is stretched.

In some cases, especially with conical teeth, the above method is not always sufficient to prevent the rubber from slipping. The slipping may sometimes be prevented by passing the end *b* as directed over *a*, then bringing it up again between the central and lateral, and over *a* once more; then applying traction as before directed. By this means the tooth is surrounded by a double strand of silk.

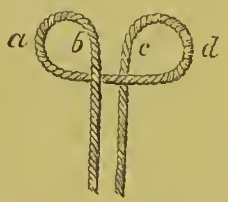


FIG. 349.

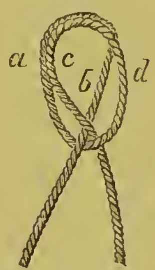


FIG. 350.

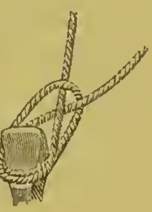


FIG. 351.

Another method of preventing the rubber from slipping is to apply an ordinary clove hitch.

This is made as follows:—Fold the piece of waxed silk as shown in fig. 349, next simply pass, not fold, the loop *c d* in front of loop *a b* as shown in fig. 350, then apply to the tooth by taking the double loop well up behind the neck of the tooth, and exercising traction alternately on the ends (fig. 351).

It is important that, in every case, the silk should be passed and the knot tied, or the twist made, on the side of the tooth away from the cavity, the reason being obvious.

Application to back teeth.—In the application of the rubber dam to back teeth, it is generally necessary to use a clamp, and if the

rubber is being applied to more than one tooth, the clamp should always be fixed on the most distal tooth. The use of a clamp prevents the cheek and tongue drawing off the rubber when in place, and allows a better view of the cavity.

When using a clamp two methods are open to the operator:

(*a*) The clamp may be applied, and the dam stretched over it—this method is handy where small clamps are used. Or,

(*b*) The clamp may be passed through the perforation in the rubber, and being placed in position on the tooth, the rubber may be gradually insinuated over its edges with the first fingers.

Having adjusted the clamp, stretch the rubber over as many teeth as is needful, using silk, if necessary, to pass it down the interstices.

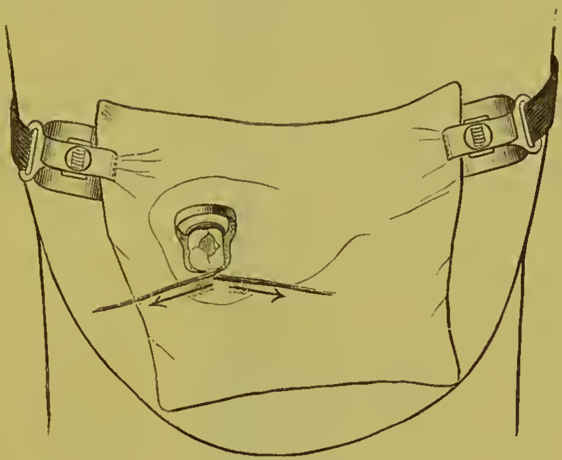


FIG. 352.

Apply the retractors, and carry silk round all the teeth, including the one on which the clamp is placed. This latter precaution is necessary, as the clamp does not cause the rubber to tuck under the gum, and without the silk a possible cause of leakage would be left. Passing the silk is best effected in the following manner:—Place the silk behind the clamp, and bring the end which is towards the inside of the mouth under the palatal or lingual flange, as the case may be, and then pass it between the approximal surfaces of the teeth in front. Repeat this operation with the other end by passing it under the buccal flange and also between the approximal surfaces. Now apply traction to the end under the palatal flange in an outward direction, and to that under the buccal in an inward direction (see fig. 352). Then cut off the ends of the

silk, or remove it altogether. In applying the silk to the remaining teeth, practically the same methods are employed as are adopted for the front teeth.

In removing the rubber the operator must be very careful that the silk ligatures are not left behind, otherwise inflammation, sometimes of a very troublesome character, results. It is well, therefore, to make a rule to take off the ligatures first, then the rubber, and

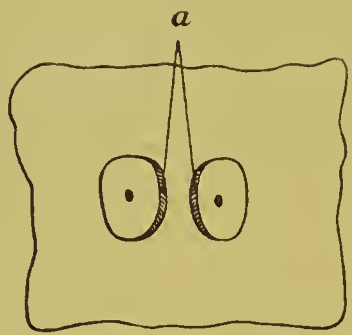


FIG. 353 (Ottolengui).—Diagram showing leakage due to leaving insufficient space between the holes in the rubber. (*a*) Indicates margin of rubber.

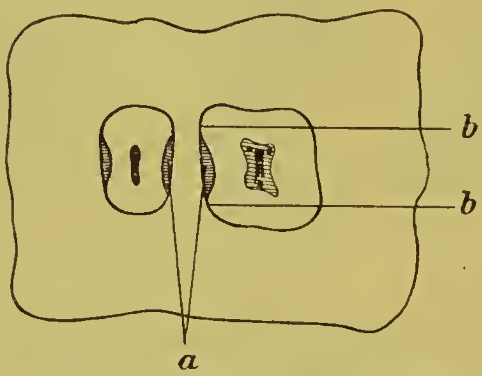


FIG. 354 (Ottolengui).—(*a*) Indicates margin of rubber; (*b*) prominences of the tooth. Diagram illustrating leakage due to shape of tooth. The rubber stretches between the prominences of the tooth, leaving a space. A pledget of cotton wool dipped in gum sandarac varnish, and held by a ligature in the space, is usually sufficient to stop the leakage.

always, after removing the latter, to look at the holes and see that they are perfect, as a ring of rubber has been known to tear off and remain on the tooth and set up trouble similar to that caused by an elastic band used for regulating purposes.

Leakage after the rubber dam is in place may be due to the holes being too large or to insufficient space between them, or to

some peculiarity in shape of the tooth (see figs. 353 and 354). Another cause is the presence of a growth of gum at the neck of the teeth, and to meet this difficulty Ottolengui suggests the following:— Pack a roll of cotton wool dipped in sandarac varnish along the leak; a ligature should then be knotted so as to present three or

FIG. 355.

FIG. 356.

four knots over the cotton, and the silk then firmly wound around the neck of the tooth. A small piece of wool dipped in collodion and wiped round the neck of the tooth will often arrest leakage by forming a film. Ottolengui also suggests a neat way of dealing with

Fig. 357.

Fig. 358.

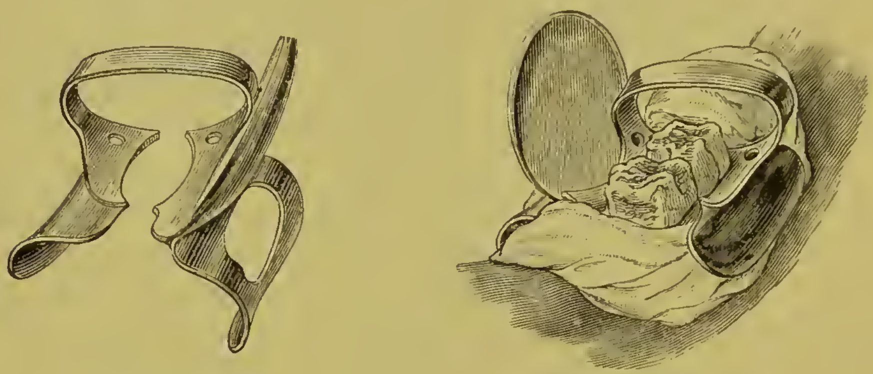
small tears. It consists in placing in the puncture a small piece of wood shaped like fig. 355.

(ii.) **The use of napkins.**—Under certain conditions napkins are useful, and, if properly applied, will often be found very effective. They should be made of the best diaper, fairly thin, and not too large, and it is as well to have a selection of various sizes. There are many ways of applying them, but the one described as follows will be found especially useful:—Fold the napkin into the shape shown in fig. 356, and take hold of it with a pair of conveying forceps about $1\frac{1}{2}$ to 2 inches from the pointed ends. For the maxillary teeth pass the napkin into the sulcus between the gum and the cheek in the region of the molars, continue the packing, bringing the napkin forward towards the incisor teeth. The remaining portion should be passed behind the molars and spread out as shown in fig. 357. While working, the operator should keep his finger well pressed on the part of the napkin which lies over the opening of Steno's duct. The application of a clamp to one of the posterior teeth will greatly assist in preventing the napkin from "pulling out." For teeth in the mandible exactly the same proceeding should be adopted (fig. 358), the bulky portion being well pressed down into the floor of the mouth, and it is as well to let the tongue lie over the napkin, rather than the napkin over the tongue, as the tongue will tend to keep the napkin in place.

In connection with the napkin, Mr. Ackery has recommended placing in the folds a thin sheet of rubber dam. The use of this is obvious. The ordinary napkin gets moistened, and gradually the whole thickness of it becomes saturated. If the rubber is used the moisture is stopped by the rubber and the side of the napkin against the tooth is thus kept practically dry.

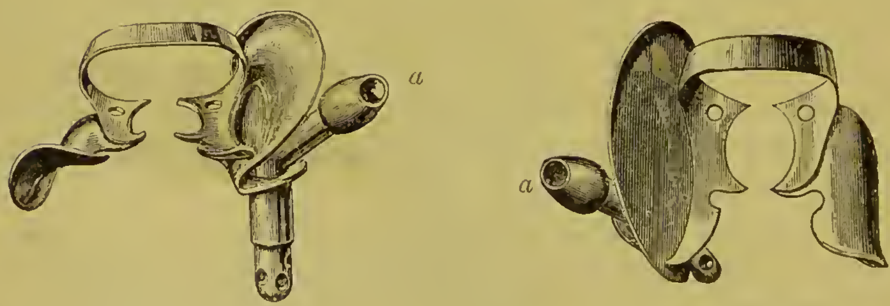
(iii.) **Bibulous paper or amadou** is used by many operators in place of napkins, and is applied by simply packing pledgets of the material on either side of the gum, holding them in position with the finger and thumb or by some mechanical contrivance. A piece of bibulous paper placed over Steno's duct will keep the outer side of the maxilla or mandible quite dry, and with the aid of the saliva ejector is often quite sufficient to keep cavities dry during short operations. In the mandible a pad should be placed beneath the side of the tongue. Rolls of cotton-wool about $1\frac{1}{2}$ inches long have recently been introduced, and they are certainly an easy and neat method of applying this class of material. In connection with

the napkin and bibulous paper, clamps are extremely useful; that shown in fig. 359 being after the design of Mr. C. Stokes. The clamp should be placed in position, and a roll of bibulous paper passed through the hole in the lip of the clamp, taken round the back of the tooth, and returned under the plain lip of the clamp. When the rolls become moistened additional paper should be packed under the lips and over that already in position. Slight tilting of the head to the opposite side will allow the saliva to accumulate and so assist in keeping dry the side which is being operated upon.



Right side. Left side.

FIG. 359.



Right side. *b* *b* Left side.

FIG. 360.—(*a*) Nipple to which the indiarubber tubing is attached; (*b*) the saliva tube.

When only a napkin is used and not the rubber dam, the moisture appears between the necks of the teeth, coming from the glands near the margin of the gum, and is extremely troublesome. A very excellent plan for obviating this is recommended by Mr. Matheson. He ties to little square pledgets of amadou a small

piece of waxed silk; the silk is passed between the teeth, and the amadou drawn into position between them.

(iv.) **The saliva ejector** is a useful adjunct to the various methods of excluding saliva, and is especially useful in conjunction with other methods. The comfort to the patient and the operator by the use of this instrument cannot be over-estimated. The mouth tubes must be sterilised after using. Saliva ejectors with specially-made clamps form a very efficient means of excluding moisture during short operations. The clamps (fig. 360) are very useful, and are after the design of Mr. Stokes. It is as well to use with them some rolls of bibulous paper. These clamps are still open to improvement, it being found that they exclude the moisture easily from the lingual surface, but not quite so effectively from the buccal.

(*b*) Methods of Separating Teeth.

The main objects in separating teeth are to give space for the free use of instruments, either for filling or examination purposes, and to enable the contour of the teeth to be restored. In young subjects the separation of teeth can be accomplished with comparative safety, but in the old wedging sometimes produces chronic periodontitis, and should therefore be used with judgment. Separation should not be adopted in any case where there is a tendency to periodontitis, or any constitutional condition militating against repair.

One author relates a case where the inflammation of the alveolo-dental membrane caused by the separator spread to the pulp and led to its destruction.

The methods of separating teeth may be divided into the "gradual" and the "immediate." For **the gradual method, tape or rubber is generally used,** commencing with narrow breadths, and gradually increasing the number till the required space is obtained. It is advisable when the space has been obtained to allow one or two days to elapse before operating, in order that the inflammation caused by the wedging may subside. The inflammation which arises from the wedging can be reduced by applications of iodine and aconite. Of the above methods tape is in most cases preferable. The disadvantages of the rubber are that it works too rapidly, and causes a greater amount of inflammation. When the teeth are very close together, it is sometimes impossible to get a strand of tape

between them, and the rubber is then very useful for commencing the separation.

Wood for wedging can be used in exactly the same manner as tape, viz., commencing with thin pieces and gradually increasing the thickness. The disadvantage of using wood is that the operator has nearly always to change the thicknesses himself, whereas patients are themselves able to apply the tape or rubber.

There are many who prefer to wedge with cotton, asserting that its action is fully as effective as other methods, and that it does not cause the slightest inflammation. Cotton is best used as follows: Take a tuft and pull it into pieces, so that the fibres are parallel to one another; next reduce one end to a thread by twisting it between the fingers and thumb; pass this between the teeth to be separated, draw it forward with a pair of tweezers, and cut off the ends close to the enamel. The saliva moistening the cotton causes it to swell and so separate the teeth.

Another method of separation especially useful with posterior teeth is to prepare the cavity roughly at the first sitting, and fill up the space with **gutta percha**, bringing it against the side of the adjacent tooth. The gutta percha should be inserted in a semi-plastic condition, and forcibly wedged up with a cold burnisher. The saliva causes the gutta percha to swell and so separate the teeth. The cheaper forms of gutta percha are best for this purpose, as they swell more easily. After being wedged by the gradual method the teeth are often found to be very tender. In such cases the operation of filling should be postponed until the tenderness has passed off, the space being in the meantime filled with gutta percha to prevent the teeth closing up. In separating the posterior teeth, the occlusion may be disarranged and periodontitis started. This is apt to occur in teeth which have tilted through travelling forward. With such teeth it is better to adopt an immediate method of separation. Of **immediate methods**, separation by means of **wooden wedges** is very simple. Two narrow wedges of fine grained wood, such as orange or box wood, are inserted between the teeth, one at the neck and the other at the cutting edge. The wedges are alternately tapped with a mallet until sufficient space is obtained. The wedge between the teeth at the cutting edge is then removed, and the other left in place. Another method of inserting wooden wedges is with forceps made for the purpose, one blade conveying the wedge, the other a pad of rubber to protect the enamel from injury whilst the wedge is being introduced.

Of the **special instruments** made for separating teeth Perry's and Ivory's are favourite patterns. There can be no doubt of the practical utility of this class of instruments. They enable the operator to complete the filling at one visit, and, with the exception of gutta percha, it is the least painful method of separating teeth. A disadvantage of all mechanical contrivances is that they are to a certain extent a hindrance to the use of the filling instruments.

In applying screw separators the instrument should be kept firmly in position with the left hand, and the turns of the screw not made too quickly. A disadvantage one often meets with in Perry's is a tendency for the instrument to slip towards the gum. This can be counteracted by placing small pieces of either gutta percha, rubber, or lead under the bows of the separator when commencing to turn the screws. Immediate separation should be used where possible, in preference to the gradual method.

(*c*) The Preparation of Cavities.

It is not intended to describe fully all the various types of cavities and methods of inserting fillings which occur in practice; attention can be directed only to the more salient and elementary points. The manipulative skill required for correctly filling teeth can only be acquired by practice.

(i.) **General points.**—Success in filling depends largely upon having the cavities carefully prepared. In the **retentive shaping** care must be taken to avoid injury to the pulp and needless sacrifice of tooth substance which might endanger the stability of the cavity walls. **The simplest mode of shaping is to cut the cavity so that some part of the interior is a little larger in diameter than the diameter of the orifice.** In cavities with all the walls standing this may be effected by making the walls slightly divergent from the orifice inwards. With cavities not possessing four walls, retention is usually obtained by means of **grooves**. These must not be too deep; a deep groove is difficult to fill and is a source of weakness. The grooves must be cut in the dentine, and in a direction parallel with the pulp. A frail margin of enamel should not be allowed to remain at the cervical portion of the cavity. For example, in fig. 361 the margin of enamel is frail and liable to fracture during filling. The cavity should be extended so as to remove all the enamel.

The **extension of cavities** beyond the actual limit of the caries is often advisable in order to remove possible sources of failure and obtain "**self-cleansing**" edges. If more than one cavity exists in a tooth, and there is little intervening tissue between them, the intervening tissue should be removed. Examples: on the occluding surface of a maxillary molar cavities frequently exist in the

FIG. 361.

FIG. 362.

FIG 363.

anterior and posterior sulci, and if, when the cavities are prepared, only a thin stretch of tissue remains, as seen in fig. 362, it is better to unite them. In teeth with cavities in the approximal surfaces, as seen in fig. 363, the intervening tooth structure should be removed, as fracture is certain to occur from the force of mastica-

FIG. 364.

FIG. 365.

tion. In cavities on the occluding surface of the premolars and molars the fissures should be freely cut out. Even if no caries is present the fissures are almost certain to become the seat of caries sooner or later.

When the wall of a cavity is in close proximity to a fissure, as seen in fig. 364, the cavity should be extended so as to include the fissure as shown in fig. 365. The extension of cavities so as to

ensure "self-cleansing" edges is most desirable. All joints between fillings and tooth substance should be made as accessible as possible to the tongue and tooth brush, so that food may be prevented, as far as possible, from lodging near them. It is also most desirable that **fillings should be in contact with the approximal tooth** to prevent injury to the muco-periosteum during mastication. In

FIG. 366.—Diagram showing cavities prepared in such a way that the junction between the filling and enamel cannot easily be kept clean.

FIG. 367.—Diagram showing cavities prepared in such a way that the joint between the filling and enamel can be easily kept clean.

FIG. 368 (Ottolengui).

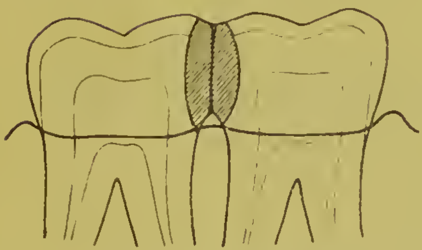


FIG. 369 (Ottolengui).

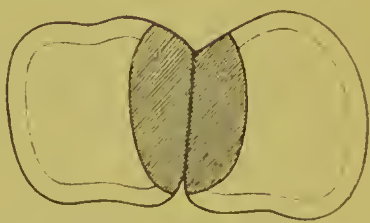


FIG. 369 (Ottolengui).

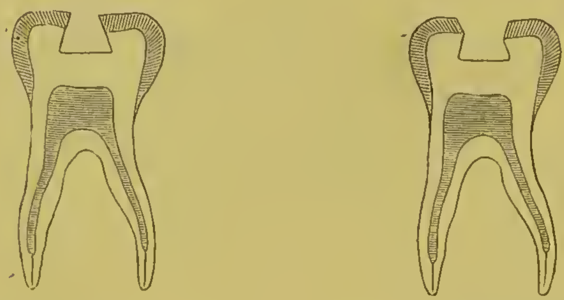
approximal cavities complicated with recession of the gum (fig. 368) the cavities should be extended to the cervical margins and to the occlusal surfaces, so that the fillings, when completed, may fill up the approximal space, as seen in fig. 369, and thus prevent the accumulation of food.

The treatment of the enamel margins.—The best results are obtained by keeping the margin at right angles to the teeth in all

except occluding surfaces (fig. 370). If the edges on occluding surfaces are left much undercut, a few enamel fibres will be unsupported by dentine—the fibres always run in a direction toward the pulp—and the result will be that, with pressure, they will give way, forming a vulnerable point in the filling (fig. 371 *a*). If, however, the margin is left but slightly bevelled, all the enamel fibres will be supported by dentine, and a source of failure removed (fig. 371 *b*).

(*a*) Enamel margins incorrectly prepared. (*b*) Enamel margins correctly prepared.

FIG. 370.



(*a*) Showing how not to leave the margins of enamel. (*b*) Showing how the enamel margins should be prepared.

FIG. 371.

The best instruments for carrying out this part of the work are fine cut cavity burs and stones.

(ii.) **Relation of the pulp canals to the surfaces of the teeth.—Maxillary teeth.**

(*a*) **Incisors.**—The pulp of the **central incisor** follows to a great extent the contour of the tooth. It is prolonged towards the mesial and distal angles (fig. 372); care must therefore be taken to avoid cutting deeply in this part of the tooth. A section of the tooth near the neck shows that the pulp lies a little nearer to the labial than the palatal aspect of the tooth; pits and grooves can therefore be

made with greater safety in the palatal part of the tooth. Access to the pulp canal should be gained through the palatal aspect of the tooth, the opening being made above the pit (*a*, fig. 373) and not through it. An opening made through the pit will meet the canal

FIG. 372.

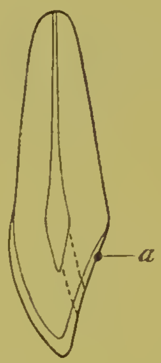


FIG. 373.

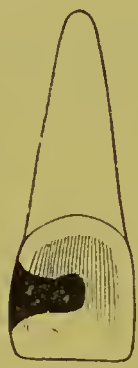


FIG. 374.

at an angle. The nearer the opening is made towards the cutting edge the more direct will be the access to the canal. The direction in which an approximal cavity should be extended to open the pulp canal is shown in fig. 374.

The enamel on the approximal surfaces ends as shown in fig. 375. This fact must be taken into consideration when preparing the cervical portion of the cavity.

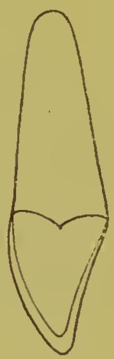


FIG. 375.

The pulp of the **lateral incisor** is practically similar in shape to that of the central, but it is larger in proportion to the size of the tooth and is therefore more often exposed.

(β) **Canine.**—The pulp is not prolonged towards the mesial and distal angles as in the incisors. In comparison with the incisors

the pulp is relatively small. Access to the pulp canal should be gained in a manner similar to the incisors.

(γ) **Premolars.**—In the **first premolar** there are usually two canals. The pulp is constricted at the neck, as shown in fig. 376.

FIG. 376.

FIG. 377.—Showing method of opening into the pulp canals of a first premolar from the occluding surface.

FIG. 378.

In extending cavities to the pulp canal it is almost always necessary to cut towards the cusps, as shown in fig. 378; the disadvantage of this proceeding is that the walls of the tooth are weakened. Care must therefore be taken to avoid unnecessary sacrifice of tissue.

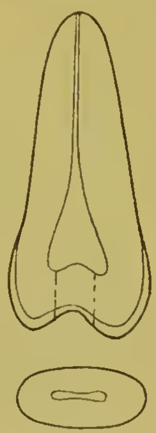


FIG. 379.

The **second premolar** usually has one root canal. The pulp is not so constricted at the neck as is the case in the first premolar. Access to the pulp canal is gained in a manner similar to that of the first (see fig. 379).

(δ) **Molars.**—The **first molar** has three roots. The pulp approaches the anterior aspect of the tooth more than the posterior. The pulp is therefore more liable to be exposed in anterior than in posterior cavities. The relative position of the orifices of the canals is shown in fig. 380. The direction of the axes of the pulp canals to the occluding surface is seen in fig. 381. Access to the canals is gained by extending the cavities towards the buccal surface as shown in fig. 381A. By this means direct access to the buccal and palatine roots can be obtained.

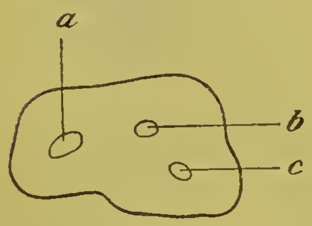


FIG. 380.—(*a*) Palatine root; (*b*) posterior palatine root; (*c*) anterior palatine root.

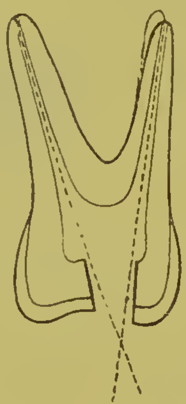


FIG. 381.

FIG. 381A.

The **second molar** has three roots. The palatine root is more in line with the longitudinal axis of the tooth than is the case with the first molar, for this reason access to the canals should be gained by extending more towards the centre of the occluding surface rather than towards the buccal aspect. The pulp, as in the first molar, is situated nearer to the anterior than to the posterior aspect of the tooth.

Mandibular teeth.

(α) **Incisors and canines.**—Access to the pulp chambers of these teeth should be gained by an opening on the lingual surface, the opening being made well towards the incisive margin (figs. 382 to 384).

(β) **Premolars.**—The crown of the **first premolar** is slightly bent on the root, the inclination being towards the tongue. A section of

this tooth shows that direct access to the pulp canal is best gained by drilling through the occluding surface just internal to the anterior cusp, as shown in fig. 385. In extending approximal cavities to the pulp canals the operation should be carried out as shown in fig. 386. The usual method of extending the cavity through the coronal fissure will strike the pulp canal at an angle, while extension as advised will give direct access to the canal.

With the **second premolar** the inclination of the crown to the tongue is not so marked, extension to the pulp canal should there-

Fig. 382.—Showing method of approaching the pulp canal in a mandibular incisor.

Fig. 383.

Fig. 384.—Showing method of approaching the pulp canal in a mandibular canine.

Fig. 385.

Fig. 386.

Fig. 387.

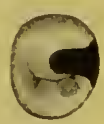


Fig. 388.

fore be made by cutting a little more towards the coronal fissure (see figs. 387 and 388).

(γ) **Molars.**—The **first molar** has two roots. The canal in the anterior root is much constricted in the centre, while the pulp canal in the posterior root is well marked. Access to the pulp canals should be gained by extending the cavity towards the central portion of the occluding surface.

The **second molar** has two roots. The pulp canal in the anterior tooth is not as a rule constricted as in the first molar. Access to the canals is gained in a way similar to that pursued with the first molar.

(iii.) **Simple cavities.**—The simplest form of cavity is that in which all the walls are complete, and good examples of this are the cavities occurring upon the crowns of molars and premolars. To shape these, the walls should be made slightly out of the perpendicular, the floor being left flat, and the edges trimmed as directed. All fissures on the occluding surface must be freely cut out.

(*a*) Showing tooth previous to preparation.

(*b*) The dotted lines show the portion of enamel to be removed by the enamel chisel.

(*c*) Cavity prepared. Note: the margins should be left a little more rounded than shown in diagram.

FIG. 389.

(*a*) First mandibular molar. Showing the portion of tissue to be removed with the enamel chisel after cutting through the fissures.

(*b*) Showing the cavity prepared.

FIG. 390.

The *modus operandi* of preparing simple cavities is as follows:—Example: carious second mandibular molar (fig. 389). With a fissure bur a cut is made through all the fissures, as shown in fig. 389 *b*. An enamel chisel is then used to break down the triangular pieces of enamel thus left. The carious dentine is then removed and the walls suitably shaped. When using cohesive gold in mandibular molars, it is often found that if the anterior wall is undercut, or even quite perpendicular, the cavity is extremely

troublesome to fill. To overcome this, that wall should be left quite sloping (fig. 391), and then it can be easily seen, and the cavity properly filled, the filling being held in by making the buccal and lingual walls of the cavity diverge slightly towards their posterior aspects.

For simple cavities on the labial, buccal, and lingual surfaces, the same rules apply as to simple crown cavities. For cavities on the incisive margin of the anterior teeth a slight undercut should

FIG. 391.

FIG. 392.—Cavity involving cutting edge of central incisor. Transverse section showing method of preparing cavity.

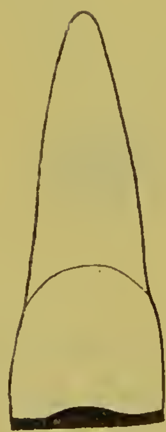


FIG. 393.—Showing cavity filled.

be made throughout the breadth of the cavity. The edges must be prepared in such a way that the filling, when inserted, completely covers them, otherwise failure through fracture of the enamel margins is liable to occur (see figs. 392 and 393).

(iv.) **Approximal cavities.** — When present on the approximal surface of the **molars and premolars**, access must be gained through

the occluding surface. This is carried out with a small fissure bur, the cut being taken well back, as shown in fig. 395. The weak edges of enamel (see dotted line, fig. 395) are then broken down. The carious dentine is next cleared away. A cavity somewhat cup-shaped will then be left to deal with (fig. 396). In the shaping it must be remembered that there are two directions in which the filling has to be prevented from coming out, the one from above downwards, the other laterally. The labial and lingual walls (*a* and *b*) should therefore be cut so as to diverge not only towards the cervical margin, but also towards the axial portion of the tooth. To carry out this step two grooves are made which diverge as they approach the cervical margin (fig. 397). The portion of tissue shown by the dotted lines is then removed, and a double wedge-shaped cavity is obtained.

FIG. 394.

FIG. 395.

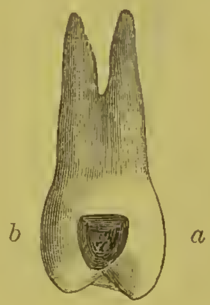


FIG. 396.

FIG. 397.

Should the fissure in the coronal surface be carious it must be cut out, but in doing this as little tissue as possible should be removed in the case of premolars. In these teeth, if large cavities are present on both anterior and posterior surfaces, the inner cusp is liable to fracture; the retention, therefore, of an isthmus of dentine between the outer and inner cusps considerably increases the stability of the tooth. In approximal cavities to be filled with cohesive gold, the filling is started by wedging a piece of gold into a pit or groove. The latter is generally preferred, and consists of a small groove slightly undercut in the cervical wall of the cavity. In a few cavities the older method of "**starting pits**" will be found useful. These pits are made as follows:—The drill is buried to such a depth that the head is just below the level of that part of the cavity where the pit is to be made,

and the head is then moved with a slight rotary motion; the result is a small cavity (fig. 398). If the drill head is rotated when only half buried a cup-shaped cavity will be produced, and this is useless (fig. 399). Starting pits should always be drilled in the dentine itself. If drilled at the junction of the enamel and dentine, one wall will be formed of enamel, which leads to fracture during filling. The direction of starting pits should be as far as possible away from the pulp.

Fig. 398.

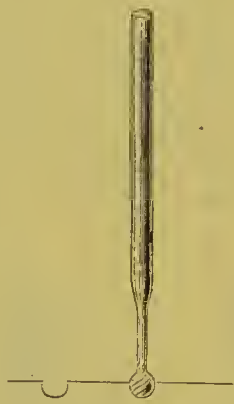


Fig. 399.

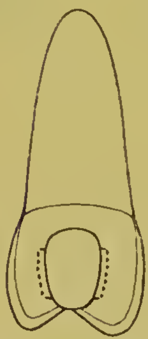


Fig. 400.—The dotted lines indicate the position of the grooves.

Fig. 400a.—View from occluding surfaces. (*a*) and (*b*) indicate the position of the grooves.

The advantage of shaping approximal cavities like a double wedge for cohesive gold is that all parts are easily accessible, and filling is thus more satisfactorily carried out. The double wedge-shape has, however, the disadvantage in large cavities of weakening the lateral walls at their coronal ends, and the inclination in practice is to avoid encroaching upon the coronal surface of the

tooth and to rely on retention by cutting two grooves on the lateral surfaces of the cavity, as shown in figs. 400 and 400A.

Small approximal cavities in molars and premolars situated near the gum may be approached from the labial or buccal walls instead of opening up from the crown, which entails the loss of much sound tissue (fig. 401). The retentive shaping of the cavity is carried out as described above. In these cavities the lingual wall forms the base. This method of treating approximal cavities is adopted when the caries is situated in the root of the tooth, as seen in patients with "recession of the gums." One disadvantage of this method is the difficulty of producing self-cleansing edges.

FIG. 401.—Showing approximal cavity in a mandibular premolar opened up from the labial wall.

Of approximal cavities in the anterior teeth the smallest are often the most difficult to fill. A good separation of the teeth is needful, as the more space available for preparing cavities the less tissue is sacrificed in retentive shaping. For small cavities for which non-cohesive gold is intended, the preparation is similar to that for simple cavities, namely, walls slightly divergent. For cohesive gold small cavities are to be prepared as follows:—With a fine finishing bur the anterior wall is cut, so that it slopes outwards and can be easily seen, a starting pit being made at the cervical margin, and an opposing point below for retention of the filling. With larger cavities, an approach should be made from the lingual aspect, the labial wall being saved as much as possible. The shaping of the cavity will then be somewhat like that of approximal cavities in premolars and molars, retention being obtained by a slight groove in the cervical wall, opposed by a small groove or pit, according to the amount of tissue available (fig. 402).

When the cavity involves the side of the tooth to a large extent, the labial and lingual walls must both be freed from all frail enamel and a different mode of procedure adopted in shaping it. **The labial and lingual walls should not be grooved.** In the cervical wall a groove should be made, and opposed by a good-sized pit drilled towards the apex of the cavity. In many cases the incisive portion of the cavity cannot with safety support an anchorage, but if the cavity is extended, as shown in fig. 403, an excellent hold will be obtained.

The preparation of cavities for plastic fillings differs slightly from that required for gold. With plastic fillings it is not requisite that all parts of the cavity should be easily accessible, and more of the tissue of the tooth can therefore be retained, but the retention

FIG. 402

FIG. 403.—From Kirk's "Operative Dentistry."

of tissue must not be carried to the extent of disregarding the general rules for the preparation of cavities. The enamel margins on the occluding surface should be straight and not bevelled, as the thin layer of enamel thus left is less likely to fracture than the feather edge of plastic material.

(*d*) Hyper-sensitive dentine.

The preparation of cavities for filling is at times hampered by hyper-sensitive dentine. The true relations of the dentinal fibril to the pulp have not been satisfactorily demonstrated, and the treatment of hyper-sensitive dentine is therefore empirical. One theory of the sensitiveness of the dentine whilst being operated upon has been brought forward by Dr. Argent, and is interesting because it offers an explanation of the action of certain drugs which are used

in treatment. The pain is attributed to pressure transmitted to the pulp. The fibril is enclosed in an unyielding case, pressure therefore on the approximal end is transmitted to the distal end and so to the pulp. A condition, therefore, which prevents this pressure, such as the formation of a coagulum in the dentinal tube, will ameliorate the hyper-sensitiveness. It is interesting to note that the most efficacious remedies are those which coagulate albumen. The area of hyper-sensitive dentine frequently varies, one portion of the tooth being distinctly more painful than another. The portions of dentine immediately beneath the enamel, and at the neck of the tooth, are usually the most sensitive.

With an acid condition of the saliva the teeth are liable to be very sensitive. The degree of pain is also, in a measure, dependent upon the health of the patient. In lowered conditions the nerve endings are often rendered more sensitive, and the sensitiveness is magnified by a diminution of the resistance to pain. The pain can, however, be greatly alleviated by keeping the cavity dry during excavation, and by using sharp instruments with a decided cutting and not scraping action.

Treatment :—

Dehydration.—The use of hot air in the form of blasts from a suitable syringe often gives good results. The application may cause a little pain, but this depends upon the tact and care with which it is applied. The hot air dehydrates the dentine. The previous application of absolute alcohol will increase the dehydration, but renders the treatment more painful. The results obtained are generally satisfactory.

Carbolic Acid.—Strong carbolic acid allowed to remain in the cavity for a few minutes and the dentine dried with hot air. This remedy is not very efficient if a result is desired at once, but if the carbolic acid is sealed in the cavity for two or three days a decided obtunding of the dentine is obtained.

Zinc Chloride.—Chloride of zinc is a powerful coagulant, and must be used with caution when the pulp is near. The cavity must be isolated and a small piece of chloride of zinc in the solid state allowed to dissolve. The application causes pain, which rapidly passes away.

Nitrate of Silver.—This drug can only be used to the posterior teeth, owing to the unsightly discolouration it causes. It is slow in its action. In superficial cavities the nitrate of silver is applied

either in the form of a fine powder on a piece of cotton wool slightly moistened, or the drug in a solid state may be rubbed over the sensitive surface. The tooth is then left for one or two days, when the dentine will be found to be less sensitive. In deeper cavities a little of the fine powder may be sealed in with gutta percha.

In cases where it is intended to use metal fillings and the dentine is sensitive, it is better to insert an oxy-phosphate filling and allow it to remain for about six months. In some instances the tooth substance is so sensitive that it is found almost impossible to remove any of the carious tissue. A filling of oxy-sulphate of zinc, if left in place for one or two weeks, will considerably allay the sensitiveness and so permit preparation of the cavity. In posterior teeth which are very sensitive the application of nitrate of silver may be substituted for the oxy-sulphate.

Sulphate of copper has a similar action to nitrate of silver.

Cataphoresis.—Electrical Osmosis.—This method depends on the power of positive currents to carry along their circuit certain medicaments. It is a method warmly advocated by some, but condemned by others on account of its uncertainty and the length of time required. The uncertainty of action, however, seems to be, in some measure, in proportion to the skill of the operator.

A good apparatus is essential. The following plan of employing cataphoresis is recommended.

The tooth must be isolated, if possible, with the rubber dam. All metallic fillings must be coated with a non-conducting material, such as gutta percha solution or shellac in spirit, and the same applies to clamps if used for retaining the dam. The dentine is next dehydrated. A small pledget of cotton wool dipped in a 30 per cent. solution of hydrochlorate of cocaine is placed in the cavity, and over this a piece of gold foil or platinum. The metal must cover the area of dentine to be treated. The anode or positive electrode is applied to the surface of the gold or platinum. The cathode or negative electrode is gripped in the palm of the left hand or applied to the outer side of the face. Metallic rings should be removed from the fingers if the electrode is held in the hand. The application of the current should commence with five volts, and after two or three minutes should be increased to ten or fifteen. The "pain limit," namely, the pressure a patient is able to bear, varies in different individuals and in different conditions of the tooth. The current is continued for ten to fifteen minutes. If at the end

of this period the dentine is still sensitive, a further application of the current should be made. The current must be turned off before removing the electrode from the cavity.

(*e*). The Use of Matrices.

The matrix, under certain conditions, is very useful. A **simple matrix** may be made out of a piece of metal bent to the shape of the tooth and fixed in position by a wedge at the cervical margin. To Mr. Lennox belongs the credit of first describing a rational method of constructing matrices which will conform well and closely to the tooth at both cervical and occlusal edges. A tooth tapers from the crown downwards and approximately resembles a cone; a matrix to fit correctly must taper in a similar way, and

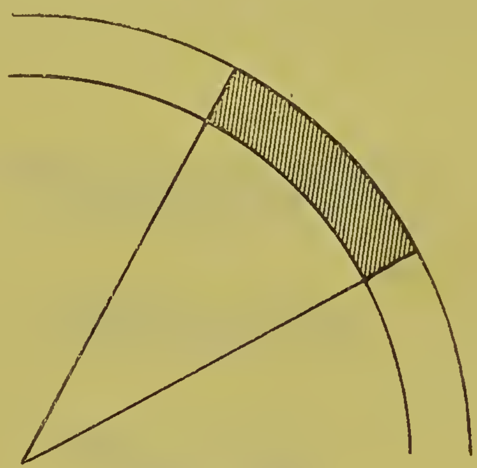


Fig. 404.

should therefore be the segment of a flattened ring of metal. It is found by calculation that the inner curve of the segment corresponds to a circle with a radius of $1\frac{3}{16}$ inches. The ends of the matrices must correspond in direction to the radii of the ring (see fig. 404). It is found that matrices for molars and premolars can be cut from a similar curved segment, the difference being a variation in the length of the segment. In fitting matrices to roots which are grooved, for instance, the anterior aspect of the first upper premolar, Mr. Lennox has suggested a neat contrivance in the form of a mandril (fig. 405), the ends of which correspond to the

Fig. 405.

Fig. 406.

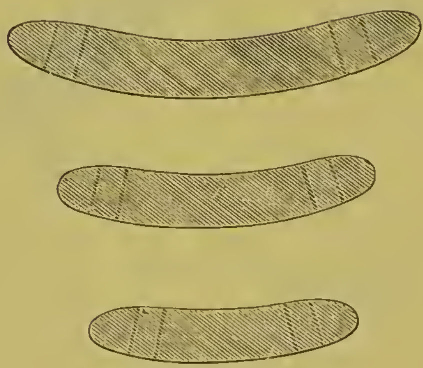


Fig. 407.—Matrices for various sized teeth.

Fig. 408.—Matrix ready for use.

cones formed by the matrices suitable for an average premolar and molar respectively. Down the mandril grooves are cut to correspond to the grooves in the teeth. The mandril is used as follows :—The lip of the matrix having been inserted into the slot in a clamp (fig. 406), the matrix is slipped on to the mandril and with a hammer tapped into symmetrical shape.

Before withdrawing the matrix from the mandril the lower margin is forced into the groove. This seems to prevent the matrix, when applied, drawing away from the groove on the tooth. In practice Lennox matrices answer admirably. Whenever used, matrices must be firmly kept in position, and should fit accurately against the cervical margin. Plastics can easily be used, but with gold much care must be taken to see that the metal is brought over the edges; indeed, it is extremely difficult to use matrices with cohesive gold. With amalgam fillings which have been contoured, great care must be exercised in removing the matrix, and generally it is better to allow the matrix to remain until the filling has hardened.

(*f*) The Use of Screws for retaining Fillings.

In places where it is not possible to shape the cavity to a "retentive" form, screws fixed into the dentine are useful. In cases where cuts and grooves would endanger the pulp or throw an extra strain on walls already weakened, the screw is also useful as a means of retention. The screws should possess fine threads varying from one hundred to about fifty to the inch according to the size of screw used.

FIG. 409.

The location of screw is of importance. If the pulp has been removed the screw should be inserted into the canal. With living pulps the screw must be inserted as far as possible from the pulp, but yet not too near the enamel margin. In incisors and canines the linguo-gingival angle is better than the labial. In the molars and premolars it is a good practice to fix the screw in the centre of the body of the tooth near the coronal surface.

When fixed in the pulp canals it is needful that the screw should be of sufficient size to obtain a firm grip—a point often overlooked. The form shown in fig. 409 is useful. The end is tapered and the screw steadily inserted.

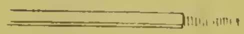


FIG. 410.

FIG. 411.

If too much force is used the root may be split. When a firm grip has been obtained the excess portion is cut off with a pair of sharp pliers. Screws should project well into the cavity. In teeth with living pulps the form shown in fig. 410 or fig. 411 may be used. A small hole is first drilled in the dentine with a suitable instrument, and the screw gradually inserted.

(*g*) The Materials used for Filling Teeth.

The materials used for filling teeth are gold, tin, amalgam, osteo-plastics, gutta percha and porcelain. Solutions of gum resins are employed in conjunction with cotton wool as temporary measures. **An ideal filling** should not only be hard enough to resist attrition, but should be able to withstand any chemical action in the mouth; it should be a non-irritant and non-conductor, and easy of adaptation: it should retain its shape and form after insertion, and lastly, the colour should resemble that of the natural tooth. At present, none of the fillings in general use fulfil all these conditions. A careful selection of the material has therefore to be made in any given case.

(i.) **Gold.**—Under suitable conditions, to be referred to subsequently, gold at present forms the best filling.

Two forms are used, viz., *the cohesive and the non-cohesive preparations*. Gold used for the production of "foil" must be pure. If silver, copper, palladium or zinc are present in small quantities as impurities its softness is impaired but not its cohesiveness. The cohesive properties of foil are destroyed by the fumes of certain gases. Cohesive gold is prepared in the form of sheets and cylinders.

A form of gold has been introduced under the name of "Solila"; it is spongy in character, and prepared by a secret process.

In the cohesive method each piece of gold is made to cohere to that already in place, and should not move in the slightest degree after it has once touched the filling. **In the non-cohesive method** the portions of the filling are held together by being intimately interlaced and wedged against each other, and over one another.

Each method has its special advocates, those for the non-cohesive claiming that it adapts itself better to the walls of the cavity than the cohesive, and can be more quickly worked; while for cohesive gold it is asserted that, though taking longer to work, it makes a harder filling, adapts itself equally well to the walls of the cavity (provided the cavity is properly prepared) and has the additional advantage in approximal cavities of being able to withstand the force of mastication.

Gold should be employed as a filling when the teeth are of fair structure, and especially in cavities in front teeth. Its use is contra-indicated in teeth the structure of which is weak, the osteoplastics and amalgams being found more suitable for such cases. In patients of highly nervous temperament or in a low condition of health the insertion of a large gold filling is undesirable. Of the two forms it may be said that non-cohesive is indicated in crown cavities, and the upper one-third of approximal cavities in molars, premolars and anterior teeth, cohesive being more serviceable when any contour is required or any strain is likely to be thrown upon the filling.

The advantages of gold as a filling are (α) that it does not alter its shape, and therefore forms a practically water-tight plug; (β) that it withstands attrition. In using gold, however, it should be remembered that it has no preservative action whatever upon the tooth substance.

(ii.) **Tin.**—Tin is very little employed as a filling by itself, being generally used in combination with gold. The advantages claimed for it are that (α) it is easy to work; (β) it has a preservative action upon the tooth substance. For the latter reason it is generally used as a lining to cavities and at cervical margins. It has one distinct disadvantage in the fact that it becomes black.

(iii.) **Plastic fillings.**

(α) **Amalgam.**—An amalgam is an alloy of which one constituent is mercury. The amalgams used in dental practice

consist of the combination of the mercury with a single metal, as in palladium, copper and silver amalgams, or with alloys of two or more metals. Amalgam has a much greater range of usefulness than any other filling. It needs, however, but a short clinical experience to discover that amalgam is eccentric in its behaviour. One filling inserted with due care will make a permanent and **reliable** plug, while another made with equal care will fail. This uncertainty in behaviour is no doubt due to some fault in our methods which, owing to our imperfect knowledge of the nature of amalgams, we are at present unable to recognise and rectify.

(1) **The experimental investigation of amalgam.**—An extended investigation of amalgams has been made by Dr. Black,[1] and he has discovered several interesting features in their behaviour. If a block of amalgam be submitted to stress and the force turned on rapidly by means of a screw, it will be found that when the stress reaches a certain point the block of amalgam goes to pieces with a crash. This point is termed the "**crushing stress.**" It is found to vary greatly with the composition of the filings, the amount of mercury employed, and the method of mixing and working. If the block of amalgam be submitted to constant stress—less than the crushing stress—it will be found that the mass gradually yields. This is termed the **flow** of the amalgam, and is common to metals under pressure. The amount of flow depends upon the pressure—the flowing being in ratio to the force employed. The flow varies according to the composition of the filings, the amount of mercury employed, &c. All amalgams, with the exception of copper, flow. Palladium was not examined. The force of mastication will produce "flow" in amalgam fillings, and is probably a frequent cause of failure. An interesting observation on this point is recorded by Dr. Black. For a family of three grown-up children he inserted many amalgams, all of which retained their edges perfectly during six years of observation. For another family of four a fair number of fillings were made with the same amalgam, and with the same care. In this family not a filling retained its margin for two years. The disposition to caries in both families was about equal. A study of the cases with the gnatho-dynamometer showed that in the second family the force of mastication was nearly three times as great as in the first.

[1] *Dental Cosmos*, 1895.

Ageing is the term used to denote the change or changes which take place in the working properties of an amalgam after being cut. The question has been very fully dealt with by Dr. Black.[1] His investigations were confined mainly to silver-tin amalgams. The changes produced by ageing on amalgams are:—

(*a*) Increase in the direction of shrinkage.

(*b*) The requirement of less mercury for amalgamation.

(*c*) The "crushing stress" is increased.

(*d*) They work more smoothly and set more slowly.

Dr. Black's experiments show that ageing is due to the effect of temperature on the cut alloys. As long as the alloy remains in the ingot no change takes place. Ageing also is not produced by light, dampness, oxidation, or motion. Cut alloys kept at a temperature below freezing do not undergo ageing. At the ordinary temperature of rooms ageing takes place slowly; for instance, in an experiment recorded, the maximum amount of shrinkage was attained in about three weeks. At higher temperatures, such as 120° F., 130° F., 140° F., the change takes place more quickly. At 120° F. the full effect is produced in three and a half days, while the action of boiling water produces the change in ten to fifteen minutes. Dr. Black explains the changes that heat effects in an alloy as follows:—Cutting or filing produces some modification, which is probably similar to the effect produced on most metals when subjected to constant hammering. Annealing the filings probably restores them to their original condition. When the annealing is properly carried out the alloy will remain in the same physical state for an indefinite period. Filings properly annealed and stored in bottles were found not to have changed in any respect.

Mr. Tomes ("Dental Surg.," Ed. iv., p. 287), finds that old, fully-set amalgams, strongly heated and at once packed in with hot instruments, make ink-tight plugs. Freshly-mixed amalgams treated in the same way give practically the same results. Amalgam used in this way sets very rapidly, in fact, too quickly to admit of its employment in practice. The rapidity of setting can be lessened by adding fresh amalgam to the reheated mixture, but the tendency to contraction is in ratio to the amount of fresh amalgam added. Mr. Tomes has also shown that the surface of a fully-set amalgam

[1] *Cosmos*, vol. xxxviii., p. 965.

presents a crystallised surface. The size of the crystals differs greatly in different amalgams, but is little influenced by the amount of mercury. "Heat causes their immediate formation in an amalgam in which it would otherwise take some hours; heating a slab already crystallised causes the disappearance of the crystals, but they immediately reform."

Mr. Amos Kirby contends that the principal cause of alteration in shape of amalgams is "an unequal distribution of mercury throughout the filling," and the experiments made by him some years ago have not received the amount of attention they deserve. His first object was to ascertain if any change in bulk took place in these substances, and if so, whether different amalgams expanded or contracted. Among the first amalgams tried was one of pure silver, which was introduced into a piece of tubing closed at one end and longer than its diameter—the filling being left flush with the

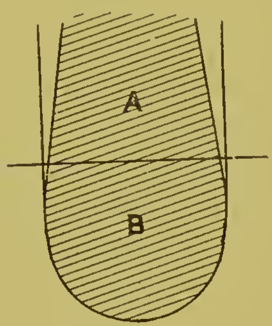


Fig. 412.

surface of the tube. At the end of twenty-four hours the amalgam protruded considerably above the orifice. The projecting part was ground off, but the next day it stood out again almost as much. The amalgam had expanded after setting and flowed out, but without splitting the somewhat thin tube. This action suggested to him the possibility of amalgam fillings adapting themselves after becoming hard. Experiments were also made with pure platinum, which expanded in a marked degree, but finally split the tube.

Amalgams formed with the alloy filings commonly used were then packed in similar tubes in the usual way. After a short time the amalgam began to contract at the free end, drawing away from the glass tube (fig. 412, *a*), and to press against the glass at the lower part (fig. 412, *b*). This action continued for several days, until finally

the contact at the lower part became so perfect that, even after exhausting the air with an air pump, staining fluids could not be forced in between the glass and the metal. It was inferred that some part of the mercury was squeezed out of the lower end during manipulation and remained in excess in the upper end, producing the soft upper surface which is so familiar, and that afterwards the lower part absorbed this excess and in doing so underwent great expansion, whilst the upper part in losing the excess contracted to an equal extent.

Working on this hypothesis, other tubes were filled in the same way, but the soft upper portion was scooped off and the cavity filled up again with an amalgam containing only a small quantity of mercury, the process of scooping off and adding dry material being repeated until no excess of mercury was visible.

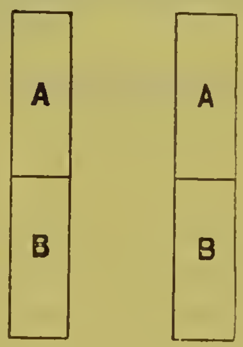


FIG. 413. FIG. 414.

After allowing these tubes to remain for some weeks, the amount of shrinkage was so small as to be practically immaterial. To make sure that transfer of mercury did take place, much longer fillings were made in holes drilled between two blocks of wood so that they could be turned out. These were manipulated in the usual way, the soft part at the orifice being left with the excess of mercury remaining on it. When hard, the first one (fig. 413) was turned out, cut in two, and each portion made of equal weight. They were then heated, the mercury driven off and again weighed. The upper portion (*a*) was found to have lost very considerably more in weight than the lower portion (*b*), proving that it had contained the larger portion of mercury. The second bar (fig. 414), made in the same way as the first, was left for several weeks before being divided. After

being heated, the two ends were found to contain almost exactly the same amount of mercury, showing that in the interval the mercury had distributed itself equally through the mass, although it had at first been much in excess at the upper end.

The lesson to be drawn from these experiments is that our fillings, immediately after insertion, should contain an equal distribution of mercury throughout their substance (and this Mr. Kirby demonstrated pretty clearly). With a view to ascertain the linear change in bulk he constructed a trough (fig. 415) with a screw micrometer attached. The trough was filled with different amalgams in the way generally adopted, viz., making one mix and gradually

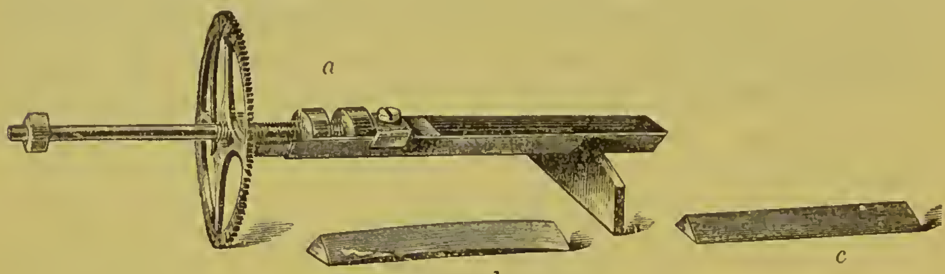


Fig. 415.

filling the cavity, taking off the excess of mercury. In all instances the bar changed shape (*b*), the alteration commencing a few hours after the insertion of the filling, and increasing considerably within the first two to three days. In order to obtain a mass of equal consistency he employed two mixings, one moist, the other dry. The softer portion was employed at the base of the filling, and the drier at the top.

Manipulation of the softer mix will bring free mercury to the surface, and this, combining with the drier mix, will tend to equalise the distribution of mercury. Bars made by this method are found to retain their shape, even after the lapse of years (*c*). If the filling be made so that there is an excess of mercury in the basal portion the tendency will be for the portion of the filling towards the surface to expand, and in practice this is an advantage rather than a disadvantage. Clinical experience shows that fillings made on the plan suggested by Mr. Kirby answer well.[1]

[1] I am indebted to Mr. Kirby for kindly revising the above remarks on his investigations.

(2) **The properties of different amalgams.**—(*a*) *Copper Amalgam.* In this amalgam the copper is obtained by precipitation on zinc rods from a weak solution of sulphate of copper, and the precipitate washed in strong sulphuric acid and dried. Mercury is then added in the proportion of 3 parts of copper to 6 or 7 of mercury and the mass made up into pellets. When required for use the pellets are heated and ground up in a mortar, and any excess mercury squeezed out, the mass being inserted fairly dry. Copper amalgam does not "flow" under stress. It does not shrink or expand. It apparently acts upon the tooth substance, and is especially useful in teeth attacked with rapid caries. The disadvantages of copper amalgam are :—(*a*) That it discolours, and at times stains the tooth substance ; (*b*) that it undergoes disintegration.

The *black discolouration* is due to the formation of sulphide of copper. This chemical action also occurs on the surfaces in contact with the cavity walls, hence the stained condition of the dentine so frequently seen. The cause of the green stain is not clear. *The disintegration* is probably brought about as follows :—Sulphuretted hydrogen, which is always present in the mouth, acts on the copper in the presence of a weak acid, forming a sulphide, and thus sets free the mercury. The rapidity of wasting varies in different mouths, and would seem to depend upon (*a*) density of the filling, (*b*) quantity of the solvent—this is probably in direct ratio to the collection of food *débris* about the teeth—and (*c*) friction. The wasting which so often occurs at the gingival margin is most troublesome. A nidus for food is formed and caries commences above the gingival margin, in fact, copper amalgam in approximal cavities has all the disadvantages of an osteoplastic in a similar situation.

The pellets should be protected from the flame by being heated in a suitable instrument.

(*b*) *Palladium Amalgam.*—Precipitated palladium is used. A large amount of mercury is required to produce amalgamation (about four of mercury to one of palladium by weight). The amount required varies with different samples of the metal. For mixing, an agate mortar and pestle are best. The combination of the palladium with the mercury is attended by the evolution of heat, often ending in explosion. The explosions fortunately never take place in the tooth, which is probably owing to the abstraction of the heat by the tooth substance. Palladium sets very rapidly ; it turns black but

does not stain the tooth. The setting may be retarded by making the amalgam in an iron mortar or pestle, which absorbs the heat. Palladium amalgam expands, and must therefore be used with care in teeth with frail enamel walls. The addition of about an equal part by weight of copper amalgam to the palladium seems to counteract the expansion and slow the setting, but has the disadvantage of sometimes staining the tooth. Palladium is a most useful filling in small cavities on the occluding surfaces, and in approximal cavities which do not involve the occluding surface. The uncertain action of palladium has been attributed to the setting free of occluded hydrogen. Palladium, when brought in contact with nascent hydrogen, absorbs it freely, probably forming an alloy. The palladium has a greater affinity for mercury than hydrogen, hence in amalgamation the latter is displaced and immediately resumes a gaseous state, causing the violent explosive action occasionally seen.

(*c*) *Silver-tin Amalgams.*—The majority of amalgams used in practice contain, as a base, silver and tin with a small varying proportion of other metals. If mercury is combined with silver an amalgam is formed which expands in setting, but discolours badly owing to the presence of sulphuretted hydrogen in the mouth, resulting in the formation of silver sulphide. Silver amalgams in addition stain the tooth substance. *If tin is added* the amalgamation is assisted and the discolouration lessened, but the tin tends to produce shrinkage, slow the setting, and diminish the edge strength. Dr. Black, who has carried out an exhaustive investigation into silver-tin amalgams, finds that alloys containing between 65 per cent. to 75 per cent. of silver, expand when fresh cut but shrink when fully aged, the expansion increasing and the shrinking diminishing as the proportion of silver is increased. Alloys containing 50 per cent. to about 62 per cent. shrink, the shrinkage being much more marked when the alloy is fully annealed. Alloys containing less than 50 per cent. of silver first shrink and then expand. When used freshly cut, the expansion is the greater; when aged, the shrinkage is the greater. The percentage of silver has a marked effect on the working of the amalgam. Alloys containing 65 per cent. to 75 per cent. of silver make hard, quick-setting and strong amalgams. Alloys with less than 60 per cent. or more than 75 per cent. of silver make soft, slow-setting amalgams. An alloy 72·5 ag. 27·5 st. after annealing does not contract or expand.

The effect of various metals on silver-tin amalgams.—Silver-tin amalgams are considerably modified in their behaviour by the addition of various metals. This question has also been investigated by Dr. Black, and the statements here made are mainly based upon his published notes.

Gold.—The addition of gold increases the edge strength or crushing stress and makes the amalgam clean and easy to work. It assists to keep the filling a good colour. The setting is, however, reduced, the shrinkage and flow increased.

Copper.—Reduces shrinkage, assists setting, and increases considerably the crushing stress. The flow is diminished. The copper has probably a distinctly beneficial action on the tooth substance, but has the disadvantage of increasing the discolouration.

Platinum.—This metal, according to Dr. Black, considerably slows setting. It reduces shrinkage. Fletcher, however, maintains that platinum gives to amalgams the property of rapid hardening.

Zinc. — Causes expansion, which takes place very slowly. Increases the setting and adds to the crushing stress. The flow is much decreased. Amalgams containing zinc require a large amount of mercury.

Cadmium.—This metal is now seldom used as a constituent of dental amalgams. It causes marked expansion and makes the mass set very rapidly. It possesses the strong disadvantage of staining the tooth substance owing to the formation of yellow cadmium sulphide.

Bismuth.—Assists amalgamation but makes the mass excessively sticky and adhesive. It lessens the crushing stress and increases discolouration.

Lead.—This metal is likely to occur as an impurity. It assists amalgamation. Makes the mass work softly and set slowly. It increases the flow and adds to the discolouration.

Aluminium.—This metal assists amalgamation and causes great expansion, but the chemical action set up during amalgamation is so violent as to render the mass too hot to handle.

(3) **The disadvantages of amalgam.**—Amalgam is the most useful of the various fillings, but it possesses two important disadvantages.

(*a*) Liability to become discoloured, principally due to the formation of sulphides from the action of sulphuretted hydrogen in the mouth.

(*b*) Tendency to alter shape.

Both these drawbacks may to a certain extent be overcome by:—

(i.) Careful attention to the composition and manufacture of the alloy.

(ii.) Attention to the preparation of the cavity.

(iii.) The method of inserting the filling.

(i.) **The effects of the various metals** has now been considered. Viewed by the light of present knowledge it appears that the basis of the alloy should be composed of silver and tin in the proportion of 72·5 to 27·5, with the addition of gold and zinc or copper when the amalgam is not to be used in a position likely to be seen.[1] In addition, it is important that the utmost care be taken in casting and cutting the alloy, and also in annealing the filings.

In alloying in the usual way in the open fire more or less of the metals are oxidised and the composition of the ingot is thus altered. Recently Dr. Black has introduced an electric crucible which is closed. During melting, a stream of illuminating gas, which is a deoxidising agent, is passed through the crucible. It is also important that annealing of the alloys should be carefully carried out, and each sample properly tested before being placed on the market.

(ii.) **The preparation of the cavities** for amalgam fillings differs but slightly from that required for gold fillings. Amalgam being a plastic material it is not so important that there should be direct access to all parts of the cavity. The edges should be left straight and not bevelled, as the thin layer of enamel is less liable to fracture than the thin ledge of amalgam which would be present if the edges were left bevelled. The student must remember that the preparation of cavities for the insertion of the amalgam fillings requires as much care and attention as gold work. Too frequently amalgam fillings are made in a careless and slovenly manner.

(iii.) **The method of inserting the filling** (see pages 347 to 350).

(4) **Galvanic action from amalgam fillings.**—The occlusion of teeth containing amalgam and gold fillings will start galvanic action under certain conditions. The following are examples from practice.

A left second molar was filled with amalgam. Occluding with

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[1] Black, *Cosmos*, vol. xxxviii., p. 991, suggests the following: 68·5 silver, tin 25·5, gold 5, zinc 1.

this tooth there was a gold crown. Two days afterwards the patient returned complaining of distinct pain every time the amalgam and crown were brought into contact, and stated that the pain was, in her opinion, due to electrical action. The whole of the surface of the amalgam filling, where the gold occluded with it, was cut out and filled with a non-conducting filling (oxy-phosphate) and the pain vanished. In another patient there was a biting-block of gold, which occluded with an amalgam filling. The tooth was not painful to heat or cold, but every time it was brought in contact with the gold biting-block pain was felt.

(β) *Osteoplastics.*—Three varieties are used—oxy-chloride, oxy-phosphate and oxy-sulphate.

(i.) *Oxy-chlorides.*—The powder consists of zinc oxide which has been heated to almost whiteness for about two hours, during which time it loses half its bulk. Borax and silica are often mixed with it with a view to increase its hardness. Oxide of zinc often contains arsenic as an impurity, but it is not probable that arsenic is ever present in sufficient quantity to exert any deleterious effect. The fluid is a solution of zinc chloride in water in the proportion of four to three. The chemical reaction of zinc oxide and zinc chloride are:

$$ZnCl_2 + 3\,ZnO + 4\,H_2O = ZnCl_2 . 3\,ZnO . 4\,H_2O.$$

Oxy-chloride of zinc does not form a permanent filling, being acted upon by fluids of the mouth, especially at the cervical margins. In places where there is much attrition it is also of little use. It is hygroscopic, sets slowly, is an irritant and an antiseptic. Oxy-chloride is principally employed as a root filling and as an obtundent for sensitive dentine. It may be employed over the pulp, but a good layer of dentine must exist, otherwise the pulp may become irritated and eventually die.

(ii.) *Oxy-phosphates.*—The powder is made of oxide of zinc. The oxides of magnesium and aluminium are sometimes added with a view of accelerating the setting. This addition is stated to weaken the resistance of the filling to lactic acid. The various shades are produced by colouring matters, and these again appear to lessen the resistance of the filling to solvents.

The fluid is a solution of orthophosphoric acid; the combination is expressed as follows—

$$3\,ZnO + 2\,H_3PO_4 = Zn_3(PO_4)_2 + 3\,H_2O.$$

Meta- and pyro-phosphoric acids, which are said to be used, form

different salts to the orthophosphoric acid. The reaction in the case of meta-phosphoric acid would be :

$$ZnO + 2\,HPO_3 = Zn(PO_3)_2 + H_2O$$

with pyro-phosphoric acid—

$$2\,ZnO + H_4P_2O_7 = Zn_2P_2O_7 + 2\,H_2O.$$

As a filling it is more permanent than the oxy-chloride. It is soluble in the alkaline secretions of the mouth. It is antiseptic, though not so marked as the chloride, and like the latter it may lead to death of the pulp if used in too close proximity to that organ. Oxy-phosphate fillings last on the average about two years, though they may continue serviceable for seven years, and in rare instances longer.

The use of oxy-phosphate is indicated—

(1) As a flooring in crown cavities (when not too near the pulp).

(2) As a root filling (to be subsequently described).

(3) As a lining to cavities with frail walls.

(4) In the teeth of children.

(5) In cavities which are sensitive, and in which it is desired to put a metal filling—an oxy-phosphate inserted in such, and allowed to remain for a period of three to six months, will act as an obtundent.

(6) In front teeth of weak structure in which gold is contra-indicated.

(7) In combination with amalgam.

(8) For the fixation of crowns and porcelain inlays.

It should not be used in cavities which cannot be kept quite free from moisture during filling.

(iii.) *Oxy-sulphate.*—In oxy-sulphate the powder is composed of a mixture of calcined sulphate of zinc and oxide of zinc. The fluid is a solution of gum arabic. Oxy-sulphate is extremely useful—

(1) As a flooring to sensitive cavities near the pulp.

(2) For covering exposed pulps (in combination with a sedative).

(3) For very sensitive cavities. A filling of oxy-sulphate used for one or two weeks will considerably allay the sensitiveness.

Oxy-phosphate of copper has been introduced by Dr. Ames, of Chicago, but it is of doubtful utility. It is soluble in the mouth and becomes intensely black. It possesses the property of being tenacious.

(γ) *Gutta percha.*—Gutta percha is the inspissated juice of

Isonandra gutta and other trees of the natural order Sapotaceæ. According to Baumhauer, the chief constituent of gutta percha is a hydrocarbon, having the composition $C_{10} H_{16}$, identical with the *gutta* of Payen, the other constituents, alban $C_{20} H_{32} O_2$ and fluavil $C_{27} H_{32} O$, being probably products of oxidation. Gutta percha is insoluble in alcohol, slightly soluble in ether, benzol, and oil of turpentine; freely soluble in chloroform and carbon disulphide. For dental purposes it is generally combined with zinc oxide and silica, with or without some colouring matter. The greater the amount of pure gutta in a sample the more valuable are its properties. The resins appear to lower the softening point, increase the time of setting, and considerably diminish the tensile strength.

Of the different **varieties**, Jacob's contains the least admixture of foreign matter when made according to the prescribed formula. The S. S. White red "base plate" is used by many in preference to any other form of gutta percha, being harder and standing attrition better.

Gutta percha deteriorates from exposure to air and light, more especially the latter. The deterioration depends greatly upon the quality of the gutta percha used in preparing the filling. A good gutta percha filling should be tough, should soften at a temperature not more than 175° F., and should set in from thirty to forty-five minutes. It should be "sticky" in working. The filling material is best preserved in the form of sticks wrapped in tin foil and kept in a box, pieces being cut off as required. The following formula is recommended by Mr. Rushton[1]:—

Pure gutta	50 parts.
Finely levigated silica	30 ,,
Oxide of zinc	20 ,,

The gutta should be gradually heated and the powders added in small quantities at a time.

Properties.—As a filling, gutta percha is a perfect non-conductor, and though it does not make a water-tight filling, fresh caries seldom seems to occur from this defect. In dirty mouths it discolours, becoming yellowish in appearance. If inserted too near the pulp, it frequently leads to the destruction of that organ. Cavities in which gutta percha is temporarily placed often appear to be more

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[1] *Trans. Odonto. Soc.*, 1898, p. 120.

sensitive on the removal of that material than before its insertion, which seems to show that gutta percha increases the sensitiveness of dentine.

Indications for use.—Gutta percha should not be used upon a masticating surface as it bears attrition badly. Gutta percha, though principally used as a temporary filling, is occasionally of great use permanently, the principal cases in which its use is indicated being:—

(1) The anterior teeth of young children, as the saliva in children seems to dissolve osteoplastics very quickly.

(2) In some approximal cavities in children.

(3) In those cavities around teeth where the decay has been brought about by clasps on dentures.

(4) In certain cavities on the buccal and labial surfaces of teeth.

(5) At the cervical margin of a cavity, the remainder of which is filled with osteoplastics.

(6) For filling root canals.

(7) As a temporary filling in cases where it is necessary to wedge the teeth (see Separation of Teeth).

(iv.) **The solution of various resins.**—Gum mastic and gum sandarach are used as temporary fillings. They harden by the saliva precipitating the resin, the solvent ether, chloroform, &c., evaporating.

(v.) **Porcelain inlays.**—During the last few years porcelain inlays as fillings have claimed a large amount of attention. They possess the advantage of more nearly resembling the appearance of the tooth than any other filling, and are therefore extremely useful for cavities on exposed surfaces. They are fixed in position with oxy-phosphate cement. In estimating the usefulness of this filling, it must be remembered that oxy-phosphate cement is acted upon by the saliva, and that the layer of cement present between the inlay and the tooth substance must be regarded as a vulnerable point. Practical experience, however, seems to show that a thin layer of cement is acted upon much more slowly than is the case with oxy-phosphate fillings. In durability porcelain inlays are inferior to gold and amalgam, but they are superior to gutta percha and osteoplastics. It is to be hoped that the use of porcelain inlays will not lead to a species of quackery.

Methods of preparation.

(i.) *The rotation method.*—To Dr. Storer How of Philadelphia

belongs, it is believed, the credit of introducing this system of inlaying.

The cavity in the tooth is gradually enlarged to be circular in outline, but slightly tapering towards the base. Fine-cut burs are needful, and the drilling must be done with delicacy but firmness of touch in order that the cavity be truly circular. A rod of porcelain of the right colour and approximate size is selected, a disc is cut off and fastened by means of shellac to a mandril rotated by the engine. With carborundum wheels the porcelain is accurately fitted to the cavity; the disc, when lying in the cavity, should project slightly beyond the surface of the tooth. The inlay is fixed with some form of oxy-phosphate mixed thin. When the cement is hard the inlay is ground flush with the surface of the tooth, and finally polished with an Arkansas stone and a little putty powder. The finishing is better carried out at a subsequent visit. The final fitting may be done by wetting the inlay with fine polishing paste and rotating it in the cavity. Care must, however, be exercised, as the disc is liable to stick fast and injure the enamel margins. Some operators prefer to cut the inlay from an artificial tooth, and, as far as colour is concerned, a more satisfactory result can in this way be obtained. The disadvantage of the rotation method is the needless sacrifice of sound tissue in many cases. Messrs. Ash and Sons have prepared a series of circular inlays of various colours corresponding in size to fine-cut burs, and by this system the process of inlaying is considerably accelerated.

(ii.) *The Dovetail Method.*—A method of inserting dovetail inlays has been suggested by Mr. F. R. Howard.[1] "Three absolutely flat walls are obtained and arranged to form a slight dovetail. Reference to the illustrations will partly explain this. Porcelain rods are prepared which are four sided and tapered in dimensions, some inch and three-quarters long, about a quarter of an inch broad at one end and rather less than an eighth at the other. The section of this rod then would appear to be an oblong, but this is not so, for the breadth on one side is slightly less than on the other, giving a slight dovetail. Three of the surfaces of this rod are ground true on a flat stone, viz., the two edges and broader side. From this, except for contouring purposes, the porcelain is not cut, but the cavity is shaped by means of fissure burs and a

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[1] *Dental Record*, Oct., 1896, p. 446.

special file to accommodate the rod along some portion of its length, the rod in this position pointing its thin end inwards."

"It is obvious, of course, that greater accuracy of fit is obtainable between two flat surfaces than two curves, and herein lies the possibility of absolute adaptability. When the fit is accurate, both on the lingual and labial aspect, the contouring of the porcelain commences by the cutting off back and front of the superfluous portions of the rod, and is complete when the bulk of the inlay is reduced very nearly to the actual contour desired."

FIG. 416.

The method requires patience, but if carefully carried out yields good results. It is, however, painful and involves in many cases the sacrifice of much sound tissue.

The following is a method suggested by Mr. Jeffery[1] for approximal cavities in anterior teeth. The inlay is made tapering in shape, and in two sections joined together by cement. The steps of the operation are as follows:—

"The teeth are first separated as for gold filling, in order to allow of the use of discs for finishing; the carious dentine is then removed, after which the double cavity is roughly made circular with rose-head burs, leaving the inner opening slightly smaller than the outer. The special bur is then taken, and with a light touch-and-go motion the cavity is made absolutely true, so that if one of the

[1] *The Dental Record*, Aug., 1898, p. 358.

tapered inlay rods be inserted it will be found to be in close contact with all edges."

"Place the rod so as to bring the connecting cement between the teeth, and mark the posterior edge of cavity on the rod with a finely-pointed pencil, then remove the rod and cut off the surplus with a diamond disc."

The inlay is inserted with oxy-phosphate cement, and at a subsequent visit the rod is divided and the inlays finished.

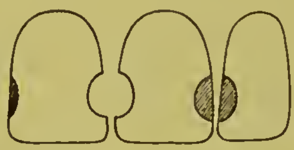

FIG. 417.—Diagram showing method of preparing and inserting the inlays.

FIG. 418.—Special bur.

Rod. Section of Rod.

FIG. 419.

(iii.) *Irregularly shaped inlays.*—The cavity is formed without undercuts, and, if on an approximal surface, it is most important that there should be ample room. The next step is the formation of the matrix. For this purpose gold foil No. 40 is used. A piece of suitable size and shape is taken, and two or three small nicks made in it. The foil is then placed over the cavity and gently pressed home with a piece of amadou, and an impression of the cavity obtained. The foil is then bent over the edges, and burnished so as to secure a sharp and exact mark of the edge. It is an advantage to melt a little wax into the matrix before removing it from the tooth. By this means the liability to crumple the matrix is overcome. With a suitable instrument the matrix is enticed out of the cavity and immediately invested in a mixture of silex and plaster.

The inlays are made from various mineral bodies. Those introduced by Dr. Jenkins yield excellent artistic results. The body is mixed into a stiff paste with distilled water, and built into the matrix and fused. The number of firings depends upon the size of the inlay. When the inlay is made it should be grooved and the cavity slightly undercut, oxy-phosphate cement being used for fixing.

Many operators prefer to take an impression of the cavity in wax, gutta percha, or modelling composition. From this impression a mould in plaster is made, and the matrix fitted either by hand or by means of a small swager. Some experience is necessary in choosing the shades for inlays, as the inlay when inserted often appears altered in colour. Deep inlays yield more satisfactory results than shallow ones, as the cement is not so liable to show through. Alteration in colour is due to the amount of light and the amount of reflection. The more perfect the front and side light, the less the variation.

Labial inlays give good results, while in approximal ones the adjacent tooth shuts off some of the light and so affects the colour, making it appear darker..

(*g*) Introduction of Filling Materials.

(i.) **Gold.**—This subject will be considered under four headings, viz.:—

(α) The method of using cohesive gold.

(β) The method of using non-cohesive gold.

(γ) Combination of the cohesive and non-cohesive methods.

(δ) Gold in combination with other metals.

(α) **The cohesive method.**—This method is more usually adopted than any other. To consolidate gold, either hand pressure or mallet force is used; in the former, the force is given to the plugger direct from the hand of the operator; in the latter, by means of a blow struck by a mallet which may be used by hand, or by some mechanical contrivance, automatic, pneumatic, engine or electric.

The *hand mallet*, the simplest of all mallets, is made of various materials and in various shapes; the usual form consists of hard wood filled with lead to obtain a dead, steady blow. This mallet is used either by the operator himself, or by an assistant; the blow delivered on the end of a plugger should have a sharp springing

stroke. Many operators claim that the results obtained by the use of a hand mallet are better even than those obtained by the electric mallet.

Automatic mallets work by the action of a special spring, and some of the modern forms have a back action. The automatic mallet should be used like a pen, with the end, if possible, resting on a finger of the left hand, thus giving the mallet a point of purchase.

The plugger should also be raised a little distance from the surface of the filling, so that each time a blow is delivered the plugger is practically thrust into the gold. Some place the plugger point on the filling, and then push the mallet, but a great amount of the force is thus lost. The automatic is a fairly serviceable form of mallet, but care should be taken to use pluggers the action of which will be as far as possible in a direct line with the force of the blow.

With *the pneumatic mallet*, force is obtained by pressure on an air bulb. The bulb is placed on the floor and lightly pressed with the sole of the foot. The blow is regulated by means of a sliding collar on the hand piece, and by the amount of pressure applied to the bulb. With this mallet several blows can be obtained in succession. The instrument is most useful in condensing gold in retaining pits and heavy foils, whether cohesive or non-cohesive.

Of *engine mallets* Bonwill's is the best. The blow is struck by the action of a cam on a pulley driven by the engine, which, as it revolves, strikes upon the edge of the plugger. The number of blows struck depends upon the speed at which the engine is worked. The disadvantage of the engine mallet is that the blow is frequently jerky, but if used with care it is undoubtedly a great help in filling. Various mechanisms are used to regulate the blow, which is consequently almost completely under the control of the operator.

The method of using the engine mallet is somewhat similar to that of the electric mallet, and will be described subsequently.

The *electric mallet* is a good instrument for condensing gold. The advantages claimed for it are :—

(i.) The blow is delivered upon the packing instrument at the point where its force is greatest.

(ii.) The force of the blow can at all times be controlled by the operator.

(iii.) It condenses the gold thoroughly and evenly throughout the filling.

(iv.) The gold can be impacted against thin frail walls with ease, and without fear of fracturing the enamel.

It is needless to say that everyone who uses the electric mallet should thoroughly understand its mechanism. Only cohesive gold should be used with it.

The following description of the method of using the electric mallet is condensed from Marshall Webb's "Operative Dentistry":—

"In commencing the filling one or two pieces of foil should be placed in the retaining point of the cavity with the instrument by hand; as each piece of gold is passed over the spirit lamp, and introduced into the cavity (either by an assistant with light pointed foil carriers, or by the operator himself with the packing instrument), and simply attached to the starting-point or to gold already in the cavity, the electro-magnetic mallet should be set in operation, and the finely serrated point of the packing instrument touched upon or placed (not pressed) against the gold, in a manner similar to that of making dots on paper with a pencil. Light, medium, or hard blows can be made without changing the adjustment of the instrument, as full or heavy lines are made on paper with a pen. When the electro-magnetic mallet is brought into operation and guided as indicated above, gold can be carried against and over the margins (even frail edges) of enamel without fracturing them, and without the packing instrument passing off and puncturing the rubber dam and wounding tissue. Almost the same blow is required throughout each and every operation, because the gold should be solid and uniform in density, hence the action of the battery must always be about the same in intensity and constancy, and the pieces of gold for a given operation ought to be nearly the same size; all foil should be rendered cohesive by passing through the flame."

Two forms of gold are usually employed, viz., tape and pellets. *The tape* is usually obtained by folding up sheet gold to the required thickness, though some firms sell the gold folded up, so that it only requires cutting to be ready for use. A sheet of gold measures 4 ins. square, and the foils are generally numbered according to the weight of the sheet, thus a sheet weighing 4 grs. is termed No. 4 thickness, a sheet weighing 8 grs. is termed No. 8 thickness. Gold tape is also numbered according to the weight of the sheet, thus, "48 tape" is tape which weighs 48 grs. per sheet

of 4 ins. square. The tape generally used is from 32 onwards. To obtain these thicknesses it is usual to fold thinner foil. Thus, No. 4 foil folded once makes No. 8, folded twice makes No. 16, and three folds make No. 32. Two or three sheets can be folded at once when greater thicknesses are required.

Instead of thin foils thus folded some use heavy or rolled gold of thickness averaging from 20 to 60. This form is extremely cohesive and useful for contouring, but it is not so easily worked, and does not adapt itself to the cavity so well as tape prepared by folding. For folding gold a pad and a foil knife will be required, care being taken that the edge of the foil knife is perfectly straight.

Having folded the gold, the next step is to cut it into strips, and an easy method of cutting it quickly and evenly is as follows:—Take the folded gold in a pair of tweezers held between the thumb and first and second fingers of the left hand, then take the foil scissors in the right hand, resting the lower blade on the third and fourth fingers of the left hand; by this means the scissors are steadied and the gold may be cut to any width desired.

The thickness of gold used varies; for retaining-pits and difficult cavities No. 32, for more accessible places Nos. 48, 64, 96. In using the heavier foils considerable practice is required. The width of strips also varies; for retaining-pits they may be practically as fine as can be cut ————; for difficult cavities ▬▬▬▬, and for more accessible places according to the breadth of the cavity.

The foil may be used in the form of *rope*. The other form of cohesive gold, viz., *pellets*, requires but short notice. There are numerous makes in various shapes and sizes; the cylinders are the most useful form, and of these Wolrab's work softly and easily. As to choice between the use of foil and pellets considerable difference of opinion prevails. Tape is probably the better, especially for building over edges and contouring. Those, however, who use pellets claim that they are more easily and more quickly worked. In some cases they may be more easy to work in the early stages of the filling, but that they can be more rapidly worked is open to doubt, for when one is able to manipulate foil of 64 thickness onwards with the electric mallet the advantage of tape over cylinders in saving time is considerable. Moisture, grease and exposure to air destroy the cohesiveness of gold, and care should be taken to avoid contact with the hands. Though foils are sold as cohesive it is always best to anneal them before using. This is usually accom-

plished by passing the gold through an alcohol flame. The alcohol must be quite pure. The safest method to avoid possible impurities from the flame is to place the gold in a tray of mica or platinum and heat it over the flame.

In annealing, avoid overheating the gold, as many kinds become harsh when exposed to a high temperature. Good cohesive gold can be annealed to a dull red heat without becoming harsh.

For **starting cohesive cavities**, two principal methods are in vogue, viz., starting pits and grooves.

Starting pits are seldom used now, except in shallow cavities.

For facility of description the *filling of cavities will be considered under three main heads*, viz., (i.) crown cavities, (ii.) approximal cavities in molars and premolars, (iii.) approximal contour cavities in front teeth.

(i.) **Crown cavities.**—These cavities are typical in molars. They are best started with cylinders or rope, as follows: Take two or three large cylinders according to the size of the cavity and with a suitable plugger, tuck them round the margins of the cavity, leaving the centre. This operation only slightly condenses the cylinders, but the gold is in a convenient position for working. Steady the cylinders with a plugger held in the left hand, and by firm pressure, first round the edges towards the walls, and then in the centre, condense the gold closely. It is very useful to condense a strip of cohesive tape with three cylinders, as it will enable the operator to start his cohesive foil more easily.

The cylinders being steady, anneal a piece of tape by passing it through the spirit flame, keeping the part between the tweezers in the flame a little longer than the rest; place the gold in the cavity and condense with suitable pluggers, using either hand pressure or mallet force. In condensing, fold the gold over so that each fold lies parallel with the floor, and exert the force in a direction as far as possible towards the walls of the cavity.

The piece being in position, fresh portions are added and thoroughly condensed until the cavity is full.

In malleting, the force of the blow should be directed towards the walls of the cavity, the most inaccessible parts being filled first, and the filling kept a little higher towards the walls than the centre. It is impossible to build the gold so accurately as to bring it exactly flush with the edges of the cavity, hence it becomes necessary to mallet the gold over the edge, and when the plug is completed, to cut down the surplus by means of burs and carborundum points.

The most important, and at the same time the most difficult, part of a filling to execute with accuracy and nicety is the operation of building over the edges. It can be accomplished as follows :—Tuck down a strip of gold near the margin of the filling, and having carried the tape over the edge, refix it again over the same spot (fig. 420). A loop of gold is thus left simply hanging over the edge ; first tap this loop down gently, and then mallet, taking care not to use too much force (fig. 421). Having built over all the edges, and filled up the centre of the cavity to the right level, the next step will be to trim the filling by cutting down the surplus over the edges, smoothing the surface and polishing. For this purpose

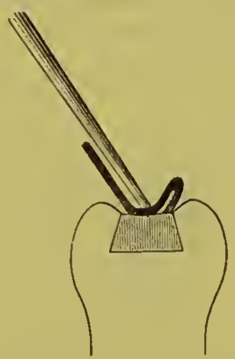

FIG. 420.—Showing loop hanging down.

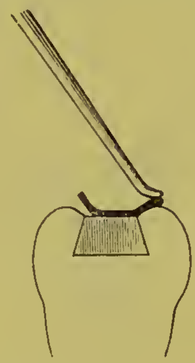

FIG. 421.—Showing loop malleted down.

finishing burs and stones are used, the former for cutting away the surplus over the edges, the latter for smoothing the surface. In using these, care should be taken to cut in a direction from the filling to the tooth, rather than from the tooth to the filling, because in the former position one is likely to burnish the gold over the edges, in the latter to tear the gold away from the edge. When the edges have been trimmed the attention should be turned to the bite, care being taken that the filling is not high (a most important point). Having ascertained that the bite is not obstructed, the surface should be smoothed first with a carborundum, and then with an Arkansas or Hindostan stone, the object of the latter being to remove scratches and so produce a higher finish ; finally complete the operation with some pumice on either a wooden or rubber point. The various steps in filling a molar are diagrammatically illustrated in figs. 422 to 427.

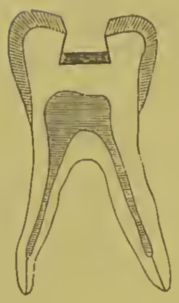

FIG. 422.—Showing the filling started by wedging cylinders into the base of the cavity.

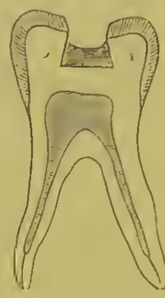

FIG. 423.—Showing how to fill the cavity, keeping the gold a little higher against the walls than in the centre.

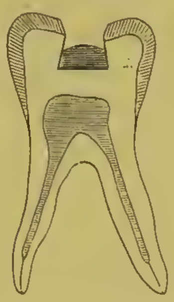

FIG. 424.—Showing how not to fill the cavity, "not to keep the gold higher in centre than at sides."

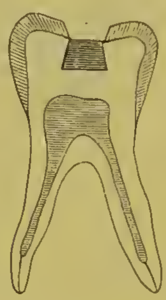

FIG. 425.—Showing the time to build over edges.

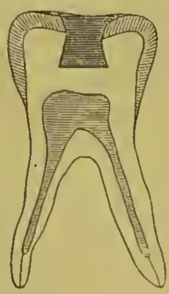

FIG. 426.—Showing the cavity filled ready for trimming.

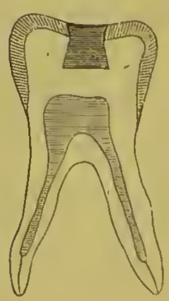

FIG. 427.—Showing the filling completed.

In trimming the edges, the joint between the enamel and the gold should not be considered perfect until the finest probe passed from the filling to the tooth, or *vice versâ*, does not catch, the edges being considered trimmed when the probe passes over all the parts without catching.

(ii.) **Approximal cavities in premolars and molars.**—These cavities are best started from a groove in the cervical wall. A piece of gold is annealed, placed in the groove and gently pressed into position. One end of the gold is thoroughly condensed while the other end is held firmly with an instrument. The condensed portion is then kept firmly pressed into place while the remainder of the gold is condensed. It is most important that the gold in the groove should be steady. If retaining-pits are used they should be filled as follows:—

In annealing the strip of gold, it sometimes happens that the end held by the tweezers does not get thoroughly annealed. To avoid this possible contingency the strip of gold should be held by one end, and when sufficiently heated, should be taken up by the other end and again passed through the flame.

Having annealed the strip, gently lay it over the orifice of the pit by means of the tweezers, and with a fine pointed plugger invaginate the gold into the pit. In removing the instrument, give it the slightest amount of rotation, this will prevent its bringing out the gold. The gold is now firmly tucked in, in successive folds, until the cavity is full.

It is essential that a firm pressure should be maintained throughout the operation of filling. The plugger used should be less in circumference than the pit, otherwise the gold will be cut in the act of filling.

The pits being filled, a bridge of gold is made from one to the other, and the foil condensed in layers parallel to the floor. The next step is to build from this bridge in a direction towards the cervical edge, using exactly the same methods as described under crown cavities; and having looped the foil over the edge, it is an excellent plan to chop off with the mallet (electric or hand) any superfluous material—this is equivalent to burnishing the gold against the edge. Too much care cannot be bestowed on this part of the cervical edge, as it is far and away the most important part of the filling.

This operation being satisfactorily completed, fresh pieces of

FIG. 428.—Showing gold bridged between retaining points, or groove filled.

FIG. 429.—Showing gold built over cervical edge.

FIG. 430.—Showing how to build, keeping the gold a little higher against the sides than in the centre.

FIG. 431.—Showing cavity full.

FIG. 432.—Showing the filling trimmed and completed.

foil should be added until the cavity is full, care being taken to keep the gold flat, and, if anything, a little higher against the walls than in the centre, and a little higher on the contour surface than towards the median line of tooth. The edges are built over as the cavity fills, the crown surface and edges being completed last.

In filling these cavities build out the contour so as to carry out the principles enunciated on page 295. The finishing of these fillings is accomplished as follows :—

The cervical edge and upper part of the plug are first roughly trimmed down with plug trimmers, care being taken to use these instruments so as to cut in a direction from the gold to the tooth substance, for the reasons previously stated. Strips of emery tape are used for finishing. The lateral margins can be trimmed with discs, but care must be taken in finishing not to destroy the "contour." To make sure that the cervical edge is thoroughly finished it is necessary, as in the case of crown cavities, to test with probes, and wherever a catch is discovered the tape and plug trimmers must be again brought into use.

If discs are used to finish the cervical margin, a depression is very likely to occur and is difficult to prevent. The crown surface is trimmed in exactly the same way as described when treating of crown cavities. The contour surface is polished with either a little pumice on ordinary sewing tape, or with rubber cups or discs on the engine. Figs. 428 to 432 represent the various stages and steps above described.

(iii.) **Approximal fillings in anterior teeth.**—In these cavities great care must be taken to get the gold into absolute contact with the front wall of enamel in order to avoid that bluish-black appearance sometimes seen in front teeth filled with gold. In filling the method of procedure should be as follows :—First fill the retaining-pits or grooves in the cervical wall and build over the cervical edge as recommended above. Next build the filling down a little way, contouring to the required shape, and taking especial care to well fill against the posterior wall (fig. 435). Now finish filling in the actual cavity, paying particular attention to the opposing point. (This stage is represented in fig. 436.) Next build over the posterior wall and edge, carrying the filling out to the required contour (fig. 437), and, this accomplished, fill the tooth in, first building over the anterior edge, and out to the required shape.

One recommends building over the posterior edge principally because the tendency is for the operator to build the filling out to the contour of the tooth in front, leaving the posterior wall, which is excessively difficult of access when the filling is completed in front.

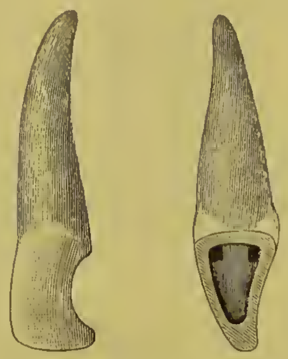

FIG. 433.—Showing side and front view of cavity.

FIG. 434.—Showing retaining points filled and bridged between.

FIG. 435.—Showing filling built down slightly and contoured.

FIG. 436.—Showing actual cavity filled in.

These fillings are best finished with plug trimmers and tape at the cervical edge, discs and tape for the approximal surface, small carborundum wheels for trimming the anterior surface, oval finishing burs, and small carborundum wheels for the posterior surface. Pumice on rubber points, or ordinary sewing tape, should be used for polishing.

The foregoing description must be regarded as a synopsis of the usual order of procedure, and not as an attempt to explain in detail the filling of cavities. There are, of course, many other shapes of

cavities besides those described, but the method is practically the same in each, viz. :—(1) To start filling from grooves or retaining-pits when present ; (2) to build over the cervical edge ; (3) to build the filling up as level as possible, keeping it, if anything, a little higher against the walls than in the centre of the cavity ; (4) to build over the edges as the filling advances ; (5) to fill the most inaccessible parts of the cavity first.

(β) **Non-cohesive method.**—For this method, as with the cohesive, the gold is prepared either in sheets or as cylinders. The sheet is usually introduced in one of three forms, viz.—

Tape or Ribbon ;
Rope ; or
Stars or Strips.

FIG. 437.—Showing posterior wall built over.

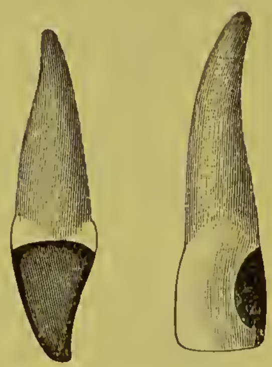

FIG. 438.—Showing filling completed.

Whichever is selected, one golden rule holds good, that **the folds of sheets or cylinders must be placed parallel to the walls of the cavity.**

(i.) Sheet.

Tape method.—In using the tape method, a sheet of No. 4 foil is cut into three pieces, and each folded with the foil knife until its breadth is about equal to that of the cavity. The strip is then taken up by the conveying forceps in the left hand and conveyed to the cavity, and with a suitable instrument in the right hand, pressed down into folds parallel with the walls, each fold being left projecting slightly above the orifice of the cavity. When a few folds are arranged, they should be firmly compressed against the side of the cavity with suitable instruments.

When one length of tape is exhausted, another is introduced, and so on, until the cavity is as full as possible. The filling is then thoroughly condensed. This step completed, the surface should be tested by endeavouring to force into the gold an instrument of wedge shape. If it can be "riggled in" by moving it in a lateral direction, the hole made should be filled up with tape or very small cylinders. This process (viz., forcing in the wedge-shaped instrument) is continued until it requires some considerable force to introduce the plugger into any part of the filling. The surface of the plug is now thoroughly burnished with either a hand or engine burnisher. The filling is then trimmed down in exactly the same manner as recommended above, with the exception that after the use of the pumice the surface should be burnished.

Rope method.—In this method the sheet, instead of being folded in strips, is rolled into a form resembling rope. The "rope" is introduced in practically the same manner as the "tape."

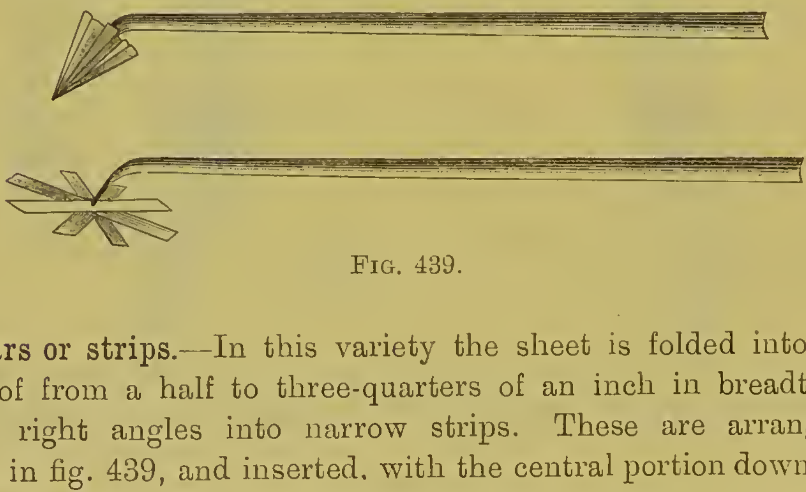

FIG. 439.

Stars or strips.—In this variety the sheet is folded into broad strips of from a half to three-quarters of an inch in breadth, and cut at right angles into narrow strips. These are arranged as shown in fig. 439, and inserted, with the central portion downwards, into the cavity, the projecting ends being folded downwards and inwards, and compressed. Fresh portions are added in like manner until the cavity is full, the plug being finished in the usual way. This process is useful for small, deep cavities, and for introducing the finishing portions into larger fillings.

(ii.) Cylinders.

Cylinders are the most convenient form in use for introducing non-cohesive gold, and one of the most serviceable makes is that known as Ash's Non-cohesive, Style C. Non-cohesive gold cylinders should be introduced as follows :—

Take three, four, or more (the number depending upon the breadth of the cavity) between the blades of the conveying forceps, and, compressing them laterally, place them in position towards the posterior part of the cavity (fig. 440), holding them in place with an instrument in the left hand; condense them first on one side, then on the other, and finally in the centre. Continue to introduce and condense fresh rows of cylinders until the cavity is a little over two-thirds full (fig. 441). A different mode must now be adopted. The cylinders should be placed round the side of that part of the cavity which is still unfilled, and condensed by wedging from the

FIG. 440.

FIG. 441.

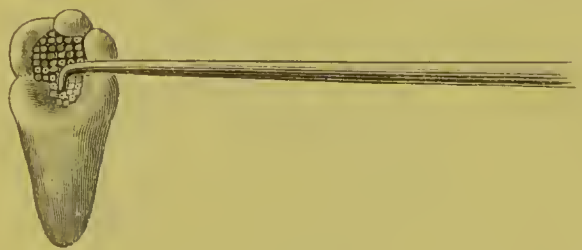

FIG. 442.

FIG. 443.—Filling trimmed and completed.

centre (fig. 442), the last portion of the filling being introduced in the form of tape. The surface is then condensed, and the plug treated in exactly the same way as described under the tape method. Very often it will be found difficult to get the row of cylinders first introduced steady when condensing; if, however, they are simply placed in position and a second or even third row added before commencing condensing, the difficulty will be overcome.

Non-cohesive gold can be most advantageously employed in crown cavities and in the upper portion of interstitial cavities in combination with cohesive. The advantages claimed for non-

cohesive gold are that it adapts itself better to the walls of the cavity than cohesive, and that it is more quickly worked—a point of great importance in practice.

(γ) **Combination of cohesive and non-cohesive methods.**—The combination of cohesive and non-cohesive is a very favourite plan with many operators. Cavities in **approximal surfaces of premolars and molars** are those usually filled by this method, the mode of procedure being as follows :—

Take two or three non-cohesive cylinders according to the breadth of the cavity, and place them along the cervical wall so that the ends project outwards, not downwards. Gently condense these with the idea of getting them steady, and add another row, condensing again, first on one side, then on the other, and finally

FIG. 444.—Showing non-cohesive cylinders in position.

FIG. 444A.—Showing the cavity completed, the light part being the non-cohesive, the dark part the cohesive portions.

in the middle. This method will prevent the gold from tilting. This proceeding is continued until the cavity is about one-third full (fig. 444), when the cohesive gold is started by wedging up a large uncondensed cohesive cylinder; tape is attached to the cohesive cylinder and the filling completed as described under the cohesive method, the plug being finished in the usual way.

The advantage claimed by advocates of this method is that a better joint at the cervical edge is obtained than with cohesive gold, while those who oppose this method maintain that the non-cohesive gold is forced out by the power of mastication and forms a ledge for the lodgment of food, &c., at the cervical edge. The objection only holds good if too much non-cohesive gold is used. A useful method of starting the cohesive gold is as follows: Before

placing the last row of non-cohesive cylinders, insert a strip of tape as shown in fig. 445, then the last row of non-cohesive cylinders, condense them and bring the ends of the cohesive strip across as shown in fig. 446.

Another mode of combining cohesive and non-cohesive gold is shown in fig. 447. The floor, walls of the cavity and edges are filled

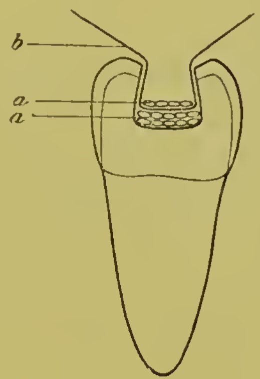

FIG. 445.—(*a*) Non-cohesive cylinders; (*b*) strip of cohesive gold foil.

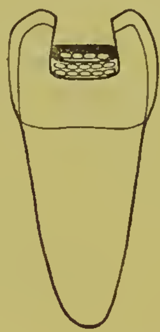

FIG. 446.—Strip of cohesive gold foil condensed over the non-cohesive cylinders.

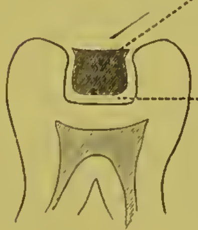

FIG. 447.

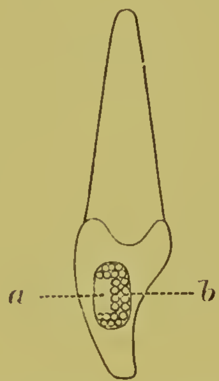

FIG. 448.—(*a*) Cohesive; (*b*) non-cohesive.

with non-cohesive gold, the centre of the plug being completed with cohesive, the idea being that the non-cohesive adapts itself better to the walls of the cavity than the cohesive, while on the other hand, the latter allows the filling to withstand mastication better than the former.

In **approximal cavities in anterior teeth** a combination of cohe-

sive and non-cohesive gold will be found useful, especially in cavities which do not involve much of the labial and lingual walls. In such cavities the cervical margins, lingual wall and portion towards the cutting margin can be filled with the non-cohesive, leaving only the portion towards the labial wall to be filled with cohesive (fig. 448). Operators skilled in the use of the non-cohesive gold method find no difficulty in filling such cavities entirely by that process.

(δ) **Gold in combination with other metals.**

(i.) *Gold and tin.*—This combination has many advocates who claim that it is comparatively easy to make water-tight fillings with it, and that, moreover, it has a preservative action on the tooth substance. The chief objection to it is that it turns black and is therefore unsightly in front teeth. It is principally used in two ways, viz., (1) similar to that pursued when using a combination of cohesive and non-cohesive gold (the tin taking the place of the latter); (2) by intermixing the tin with the gold as follows: One sheet of tin is placed between two of non-cohesive gold and the whole folded up into either tape or rope, the material being introduced into the cavity as recommended above for the non-cohesive gold. Tin and gold works softly, but subsequently some chemical action takes place, the surface becoming quite hard.

(ii.) *Gold and amalgam.*—This combination is extremely useful in cases where the cervical edge is below the gum, as, for instance, in the buccal cavities of molars and approximal cavities where the cervical edge of the cavity is high up and inaccessible.

The combination is used in two ways:—

(1) At the first visit, the part of the cavity where the amalgam is to be used is filled in the ordinary way, the remaining part being filled with soft gutta percha or cotton wool and mastic; at the second visit the amalgam is trimmed and the remaining portion of the cavity filled with gold.

(2) At one visit the amalgam is inserted, all excess of mercury removed and the gold then started on the top of the soft amalgam. It will be found that the first two or three pieces of gold apparently disappear, but the gold soon takes up the residual mercury and the rest of the filling retains its ordinary colour. The filling is completed in the same manner as a simple cohesive gold filling.

(iii.) *Gold and platinum.*—With this combination the leaves of platinum are gilded and made adhesive, and then worked in in parallel layers. Great care is required to thoroughly anneal the

strips and also preserve the parallelism, otherwise when the filling is completed patches of platinum will show on the surface. This combination is said to be valuable for cavities on the labial surfaces of front teeth, the tint approaching the colour of the normal teeth. It looks black by artificial light. Its use is practically abandoned.

(iv.) *Gold and osteoplastics.*—This combination is used principally as a means of starting cavities. In deep cavities when it is found needful to insert a covering of osteoplastics it is useful before the filling has hardened to knead into it one or two strips of cohesive gold; by this means an excellent holdfast is obtained.

(ii.) **Tin.**—Tin when used alone, is inserted on the same lines as non-cohesive gold, but in working it will be found more plastic.

(iii.) **Plastics.**

(*a*) *Amalgam.* — There are many ways of inserting amalgam fillings, and of these, three call for special mention. *Dr. Flagg*, who is a great authority upon plastic fillings, objects to the method of burnishing in the separate portions, maintaining that it is impossible to get union between successive pieces. He recommends that each piece should be worked into place with serrated pluggers, the force used being a succession of light blows. *Dr. Bonwill's method* has many advocates. He uses amalgam fairly plastic, and proceeds as follows:—A small quantity is introduced into the cavity, and over this a pad of bibulous paper is placed and firmly pressed against the amalgam with suitable instruments, burnishers, tweezers, &c.; the pad is then removed and is seen to contain a certain amount of mercury, while, at the same time, a large amount is also seen upon the surface of the filling; this is removed and another portion of amalgam inserted and treated in the same way, much pressure being used in its insertion; by these means the cavity is filled, great care being taken to remove the surplus mercury from the surface.

Mr. Kirby, to whose experiments we have already referred, adopts the following plan, which yields excellent results:—Two portions of amalgam are mixed, the first by taking equal parts by weight of mercury and filings, varying the latter a little according to its quality and age: this is the soft amalgam; the second or dry one, is made by taking three times as much filings by weight as mercury. The first half or two-thirds of the cavity is filled with the soft amalgam which is worked into position with a burnisher without any undue pressure; the upper half or third of the cavity is then

filled with the dry amalgam in much the same manner; the filling is then trimmed into shape. Mr. Kirby lays great stress upon having the smallest possible portion of mercury in the last part of the amalgam, and to ensure this he has designed a balance which turns to the fraction of a grain (fig. 449). He has also introduced a

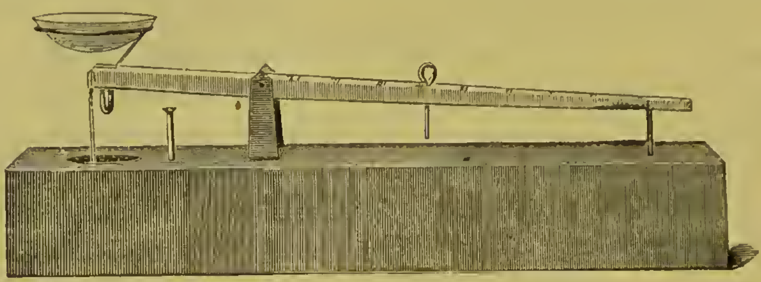

FIG. 449.

FIG. 450.

FIG. 451.

mercury holder and mixing tubes, illustrations of which are shown in figs. 450 and 451.

Mr. Kirby's method aims at obtaining an equal distribution of mercury throughout the filling. His experiment, it will be remembered, shows that after a lapse of time the mercury, if unequally

distributed, tends to disseminate equally throughout the filling, causing contraction in the part it goes from and expansion in the portion it goes to. In inserting fillings, an endeavour should be made to get the portion of the mass towards the surface as dry as possible so that the accession of mercury to this part from the base of the filling will lead to expansion.

Matrices should always be used in approximal cavities, as it is nearly impossible without their use to insert good fillings in these situations. When the filling is inserted, the amalgam should be trimmed, especially at the cervical edge, and when thoroughly hard, polished in the same way as an ordinary gold filling. For trimming the approximal surface of the filling, a strip of rubber dam dipped in water should be passed between the teeth to the cervical edge and gradually withdrawn with a side-to-side motion; by this means the surface is left quite smooth. Another good plan is to pass up a double strand of silk before commencing the filling, and when the filling is inserted, the silk can be moved from side to side and withdrawn. Another method adopted by some in filling approximal cavities is to separate the teeth and fill between the two with one mass of amalgam, then trim the fillings towards the cervical edge, leaving them continuous above; when hardened they are divided at this part with a fine disc, and the filling trimmed and polished to the required contour.

The combination of oxy-phosphate cement with amalgam.— Clinical experience shows that this combination leads to excellent results. Two mixes of amalgam should be made as recommended by Mr. Kirby. The cavity is thoroughly dried and lined with oxy-phosphate cement mixed fairly thin. A ball of amalgam is next inserted and pushed well home into the cement so that the whole surface is covered with a layer of amalgam. The cement is now allowed to slightly set and all surplus very carefully trimmed away from the margins of the cavity, the remainder of the cavity being filled on the lines suggested by Mr. Kirby. In this way fillings can be made which withstand the ink test. The osteoplastic seems in some way to lessen the alteration in shape of amalgam, besides which it is a non-conductor and prevents staining of the tooth substance.

Some operators combine the oxy-phosphate and amalgam as follows: The amalgam is mixed in the usual way, care being taken to avoid an excess of mercury; the osteoplastic is then mixed a

little thinner than usual and the two thoroughly blended together, the filling being inserted like an ordinary osteoplastic filling. The amalgam in the mixture should vary between one-third to one-half of the whole bulk.

Mixing amalgams.—In mixing amalgams it is desirable to ascertain the proportion of mercury to filings which is necessary to produce a mass of a certain consistency. The required amount of mercury and filings should be weighed out, and for this purpose Mr. Kirby's balance (shown in fig. 449) is useful. The mixing may be done in a mortar and pestle, or, for preference, in an "agitator" similar to fig. 450. Mixing amalgams by "agitator" seems to ensure a more thorough intermingling of the metals. In mixing, it is better to err on the side of an insufficient amount of mercury, adding more if needful.

(β) *Osteoplastics.*—For the insertion of these fillings it is important to exclude the saliva, and the rubber dam should therefore be applied whenever practicable. For mixing, a glass slab with square edges should be used; the spatula should be stout, quite flat and with square edges. The question of the consistency of the osteoplastics to be used must, to a great extent, be determined by experience; they should not be inserted too dry, a fairly plastic condition being the best.

In mixing, the powder is to be gradually incorporated with the fluid. The filling should be worked into place with suitable instruments; the setting can be accelerated by the use of the hot syringe, and the filling completed by trimming with cuttlefish discs, &c. Mr. Humby has shown that it is possible to retard the setting of these cements by mixing them on a slab of metal with a metal spatula, the slab being made of pure copper, covered with thin layers of pure nickel. It is supposed that the setting is retarded by the absorption of the heat generated by the combination of the liquid with the powder. A large quantity of powder insufficiently mixed makes a poor filling, but it is useful for temporary work.

(γ) *Gutta percha.*—To insert this material, the following plan should be adopted: The variety to be employed must be cut into small pieces and heated over a hot water bath; if softened by being passed through a flame the gutta percha is not evenly heated, and its properties are impaired. The cavity should be thoroughly dried, and some operators wipe it round with a solution of gutta percha or shellac in chloroform, evaporating the chloroform with a blast of hot

air before inserting the gutta percha. By this means the filling is made to adhere to the walls of the cavity. The heated gutta percha is then conveyed and packed into the cavity with suitable instruments. The cavity should be somewhat over-filled, the surplus being removed with thin spatulæ heated nearly to redness. The surface should then be smoothed with a polished burnisher, or by means of rubbing the surface with a pledget of cotton-wool dipped in chloroform. The objection to the chloroform is that the surface is rendered more porous than when the filling is finished with a burnisher. In practice better results are obtained by trimming the filling to a point just below the enamel margins.

(2) EXCISION.

In the operation of excision the diseased part is cut away and the surface polished. It is applicable in very few cases, the most suitable being the approximal surfaces of the molars and premolars, when the caries is quite superficial and the surfaces are exposed. It may also, under similar conditions, be performed on the front teeth.

FIG. 452.

The operation is best carried out with thin carborundum wheels on the dental engine, and the surfaces left should be so shaped that they can be easily cleaned. After cutting away the carious tissue, the exposed surface should be carefully polished with Arkansas stones, pumice, &c. After the operation, the teeth are often a little sensitive ; this can be relieved by the application of absolute alcohol. Some practitioners employ excision extensively, cutting away large portions of the tooth. The spaces thus formed should be V-shaped. In the case of the incisors, the base of the V is towards the lingual surface of the teeth. This operation is extensively employed by Dr. Arthur, and fig. 452 gives a good idea of the shape of the surfaces left after the operation.

(3) THE USE OF DRUGS.

The progress of caries may be considerably retarded and sometimes arrested by the application of certain drugs, the most useful of which is nitrate of silver. Drugs can be employed with advantage for the superficial caries of the cementum.

The **nitrate of silver** is applied in the form of a saturated solution, or still better, the solid drug is rubbed over the surface. Two or three applications, at intervals of about a week, will effect a considerable hardening of the surface. The nitrate of silver precipitates the albumen in the tubules and forms an albuminate of silver, which is a powerful antiseptic. The discolouration produced is an objection to its use on the anterior teeth. In cases of general softening of the cementum often seen in patients where the gums have receded, the application of nitrate of silver to the back teeth and **phosphoric acid** to the anterior teeth, with the regular use of **alcohol**, will retard, and often arrest, the condition. The alcohol should be used as follows :—

The teeth are to be dried and absolute alcohol applied to the roots either on a brush or cotton wool, the saliva being kept away for about two minutes. The alcohol precipitates the albumen in the tubes and in evaporating helps to dehydrate the dentine. The application should be made at least once a day. In the extensive caries at times seen in the deciduous teeth, the application of nitrate of silver every two or three months and the regular use of the alcohol will often arrest the caries and give the child the use of a masticating surface—a point of the greatest importance.

(4) THE OPERATION OF CROWNING.[1]

The operation of crowning may be resorted to in cases where the destruction of the crown by caries is so extensive as to prevent the introduction of reliable fillings.

Teeth or roots to be crowned must be rendered quite free from periodontitis, and the root canals made absolutely aseptic. The

[1] It is only intended in this section to draw attention to the more salient points to be observed in crowning. The advantages, disadvantages, and manufacture of the varieties of crowns cannot, owing to space, be included in this book. The student should consult the excellent work of Evans on artificial crown and bridge-work.

apex of the root canal should be filled before any reaming of the canal is carried out; in this way the infection of the periodontal membrane by foreign matter is prevented.

There are many **varieties of crowns and methods of crowning**. Broadly they fall under two headings: (i.) crowns without collars, and (ii.) crowns with collars. In the **crowns with collars** the neck of the root is embraced by a ring of metal, which prevents foreign matter coming in contact with the surface of the root and so preserves it. Beyond this, the ring gives additional strength to the crown. A disadvantage of the collar is that the margin of the periodontal membrane is often injured and destruction of that tissue occurs. It is often better, if sound tissue exists above the neck of the tooth, to employ contour amalgam fillings to restore the lost tissue. The periodontal membrane is by this means not interfered with, a point of importance. It is stated by some operators that all teeth to be crowned should be collared as it is the only means of preserving the root. Experience, however, teaches that uncollared crowns answer extremely well.

With the anterior teeth **crowns without collars** can be used on roots that are strong, namely, those in which the portion of tooth tissue above the gum is quite healthy, as the additional strength which the collar gives is not required in anterior teeth.

Crowns with collars should be used—

(i.) Where the canal is short.

(ii.) Where the strain on the crown during mastication is great, for example, where the posterior teeth are absent and the patient refuses to wear dentures.

(iii.) Where a portion of the root is much below the gum; in these cases a partial collar is useful.

For anterior teeth two classes of crowns are in general use: (i.) metal-backed or porcelain-backed flat teeth fixed to a metal diaphragm; (ii.) all porcelain crowns, of which there is a great variety.

The porcelain crowns possess the disadvantage of being difficult to accurately fit to the surface of the root. Beyond this, the limited supply of shapes and colours prevents their adoption in many cases.

For posterior teeth a collar crown should be used wherever possible. In places not visible a plain metal crown is to be preferred to a porcelain one, on account of (i.) strength, (ii.) the ease with which it can be contoured and so brought in contact

with the approximal teeth—a point which should not be overlooked.

In preparing roots for crowns the student must be guided by the class of crown to be employed. If using a metal or porcelain backed crown, the labial edge of the root should be cut below the free edge of the gum down to the attachment of the periodontal membrane; the remainder of the root should be left flat and cut so that the margin is either below or well above the free edge of the gum. In enlarging the root canal to receive the pin of the crown, the tissue should be removed mainly from the posterior portions, as this will permit the pin to clear the tooth and so add to the strength of the crown. For porcelain crowns the surface of the root should be left flat, as a better adaptation of the crown to the root will be obtained. For collar crowns the walls of the root should be shaped so that they diverge slightly from the neck towards the apex, the top surface of the root being made flat. With the posterior teeth the buccal and lingual margins can be shaped with carborundum stones and finished with enamel cleavers. The approximal surfaces are best shaped with thin wheels or V-shaped dividing files. The angles of the root are best rounded off with enamel cleavers. On the correct shaping of the root depends to a large extent the success of collar crowns. If plain metal crowns are to be used, as much tissue as possible should be left.

The correct measurement of the root is best carried out by means of Herbst's bands. These bands are made of fine gold, graduated in size, and correspond to similar sizes on a flat gauge. The method of measuring with graduated bands is superior to that usually employed, namely, twisting a piece of soft copper wire around the root.

In fixing crowns the root should be dried as thoroughly as possible. In crowns without collars a wafer of gutta percha should be placed over the surface of the diaphragm, the crown forced well home, then removed and all excess gutta percha cut off. The crown should then be fixed in the root with an oxy-phosphate cement. Crowns with collars are best fixed with oxy-phosphate cement.

(5) THE OPERATION OF EXTRACTION.

In all cases of caries where one of the above methods cannot be employed the tooth should be removed.

CHAPTER IX.

Destruction of the Tooth Substance from Causes other than Caries.—Erosion, Attrition, Abrasion.

In caries of the teeth, the tooth substance is gradually destroyed by the action of acids and micro-organisms. Progressive destruction of the tooth substance may, however, be caused by other agencies, which will be referred to as erosion, attrition, and abrasion. The destruction of tissue may be rapid or slow and may vary in intensity in the same individual. The lesion may be arrested in its progress. It is probable that the different lesions met with are merely varieties of one condition, but until their pathology is definitely ascertained it seems advisable to retain the terms erosion, attrition and abrasion, limiting the first to conditions where the causes are not defined, the second and third to conditions where the causes are to some extent known. In all these conditions there is a gradual disappearance of a portion of a substance of the tooth, the surface left being smooth in character.

(A) EROSION.

Character of the lesion.—The appearances presented by erosion vary considerably. The labial surfaces of the anterior teeth may be attacked, the condition being limited to one tooth, or involving several. The first indication is a slight depression which gradually deepens and extends towards the incisive margin.

The depression in time becomes cup-shaped, the deepest portion being towards the cervical margin and gradually lessening as the incisive edge is reached. Fig. 453 is an example of an advanced case.

In some patients the teeth look as if they have been pared down with a knife in a direction sloping from the labial to the lingual surfaces, and when the mouth is closed a considerable interval is left between the maxillary and mandibular teeth (figs. 454 to 456).

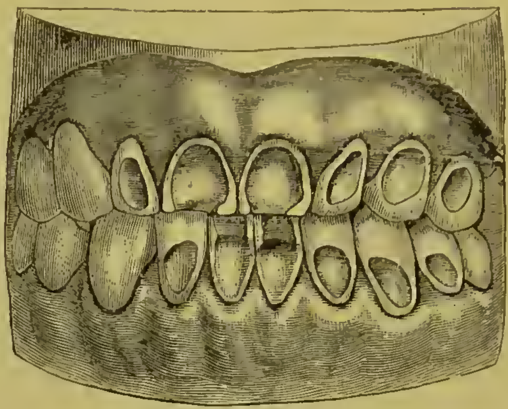

Fig. 453.—From "The American System of Dental Surgery."

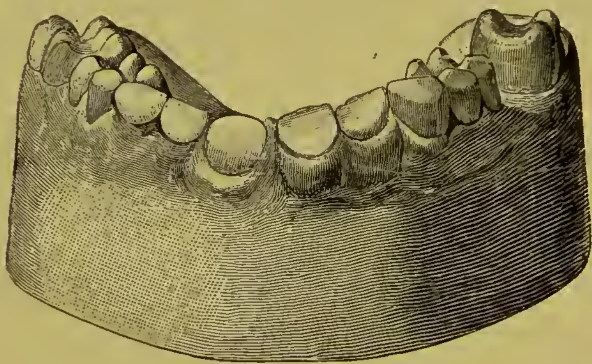

Fig. 454.—Maxillary teeth.

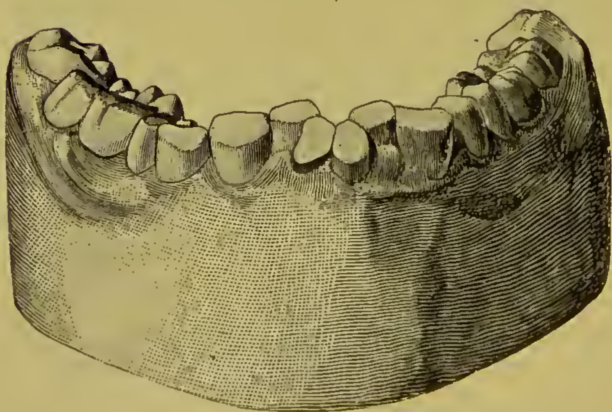

Fig. 455.—Mandibular teeth.

In rare instances the lingual surface may be attacked. A case of this latter variety was recorded by Mr. Ackery in *The Transactions of the Odontological Society* for November, 1890, and the teeth are shown in fig. 457. This patient had never worn a plate or used a tooth-pick.

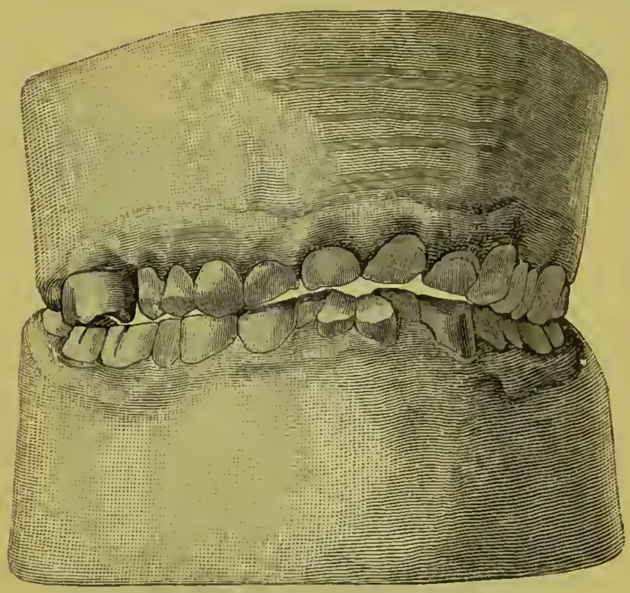

FIG. 456.—Showing occlusion of the Teeth.

FIG. 457.

To the naked eye teeth attacked by erosion appear hard and polished, with, occasionally, a darkish film on the surface. The dentine exposed is hypersensitive. The erosion usually commences on the enamel.

Microscopical appearances.—In the enamel of eroded teeth Mr.

A. S. Underwood[1] has met with an appearance suggestive of interglobular spaces (fig. 458). He states that he has never seen this condition except in enamel which was the subject of erosion.

Sections of **the dentine** simply show the fibrils or tubes ending abruptly as if cut with some sharp instrument. It is interesting to note that the tooth substance adjacent to the eroded surface cannot be stained.

FIG. 458.
(From the *Journ. of the Brit. Dent. Assoc.*)

Changes in the pulp.—In teeth undergoing erosion formative activity occurs in the pulp, resulting in the formation of adventitious dentine at the pulp end of the irritated dentinal fibrils. If the eroding process is rapid the destruction of the dentine may outstrip the formation of protective dentine. The pulp then becomes exposed and a septic inflammation occurs.

Experimental reproduction.—Dr. Black[2] has produced, by the prolonged action of dilute acids upon teeth, a condition in some respects resembling erosion. He records one experiment in which two fresh, healthy premolars were placed with their approximal surfaces together, the roots being enveloped with gutta percha

[1] *Journ. Brit. Dent. Assoc.*, p. 470, 1898.
[2] "American System of Dental Surgery," vol. i., p. 1004.

so that only the crowns were exposed; these were then placed in a jar containing dilute hydrochloric acid (1 in 400), and by means of an ingenious apparatus a current was obtained, the teeth being arranged in such a way that the current, in impinging upon their outer surfaces, struck one with greater force than the other, the result being the disappearance of the cusps and the formation of a groove between the teeth; this groove was more marked upon the one which received the greater force of the current. A large number of other observations were carried out, and it was found that strong solutions produced general softening, while a solution of 1 of acid in 5,000 of water had not an appreciable effect after three months' trial.

Etiology.—Clinical observations distinctly show that there is an intimate connection between erosion and the gouty diathesis. From the chemical structure of the enamel it is evident that the essential factor in producing the lesion must be an acid capable of decalcifying the enamel. In seeking the source of this acid clinical facts assist us. The erosion occurs in localised parts of the tooth. This indicates that the acid has a local and not a general origin. If the acid were of a general origin we should expect to find the whole tooth affected. The erosion (with the rare exception recorded by Mr. Ackery) occurs on the labial and buccal surfaces of the teeth. This would seem to localise the origin of the acid to labial and buccal glands, namely, those in constant contact with the teeth. If the mucous surfaces of the lips in cases of erosion be examined, the glands will often be found swollen and hyperæmic. It is argued that the glandular condition is the result of irritation from the margins of the eroded cavity, but careful observation shows that in many cases the teeth are not the cause. These glands are muciparous, and according to Brubaker[1] their secretion is composed of water, mucin and inorganic salts, the chief of which is sodium phosphate, which imparts to the fluid its alkalinity. Under conditions of irritation and consequent hyperæmia, the secretion increases in quantity and is acid in reaction. This observer considers that under certain conditions acid sodium phosphate is formed and that this is the decalcifying agent.

Sodium phosphate in the presence of carbonic acid readily parts with one atom of its sodium, forming acid sodium phosphate.

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[1] *International Dental Journal*, p. 742, 1894.

$$Na_2HPO_4 + H_2CO_3 = NaH_2PO_4 + NaHCO_3$$

Carbonic acid has not been demonstrated in the mouth, but a probable source is from the increased activity of gland cells leading to an excess of CO_2 in the cell tissue. The acid sodium phosphate, if formed, would theoretically be able to bring about a solution of the enamel as follows :—

$$\underset{\substack{\text{(Acid sodium}\\ \text{phosphate)}}}{NaH_2PO_4} + \underset{\substack{\text{(Calcium}\\ \text{phosphate)}}}{Ca_3 2(PO_4)} = \underset{\substack{\text{(Sodium calcium}\\ \text{phosphate)}}}{NaCaPO_4} + \underset{\substack{\text{(Acid calcium}\\ \text{phosphate)}}}{2\,HCaPO_4}$$

The acid calcium phosphate thus formed is acted on by another molecule of acid sodium phosphate as follows :—

$$\underset{\substack{\text{(Acid sodium}\\ \text{phosphate)}}}{NaH_2PO_4} + \underset{\substack{\text{(Acid calcium}\\ \text{phosphate)}}}{2\,HCaPO_4} = \underset{\substack{\text{(Sodium calcium}\\ \text{phosphate)}}}{NaCaPO_4} + \underset{\substack{\text{(Diacid calcium}\\ \text{phosphate)}}}{Ca\,2(H_2PO_4)}$$

In this way the calcium phosphate of the teeth undergoes decomposition into first mono and second diacid calcium phosphate, the latter being freely soluble.

Brubaker immersed teeth in a weak solution of acid sodium phosphate and daily subjected them to the action of the tooth brush, at the end of a week grooves and spots resembling erosion made their appearance.

Mr. Percy Richards, analyst to Charing Cross Hospital, states that the reactions are possible and may take place. It is quite possible that the removal of the softened substance would be accelerated by the muscular action of the lips, for such movements seem to sweep, as it were, the labial surfaces of the teeth.

Mr. Michaels[1] states that the saliva of patients presenting erosion shows an increased amount of sulphocyanide in the form of the ammonium and potassium salts. He states that by submitting the tooth to a slow drip of a solution of sulphocyanide of potassium for a few days he was able to produce conditions similar to erosion. Alkaline sulphocyanides (potassium and ammonium) are supposed "to dissolve the organic elements of the dental organs and lay bare the mineral elements, forming with them a sulphocyanide of calcium and soluble phosphates of potassium and ammonium."

Znamensky[2] considers that the enamel plays no part in the

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[1] "On the Rôle of Systemic Hyperacidity and of Sulphocyanides in the Saliva in Chemical Abrasion of the Teeth."—*Inter. Dental Journal*, 1899.

[2] *Journal Brit. Dental Assoc.*, January and February, 1898.

process, but that erosion is due to a solution of the animal and organic constituents of the dentine. The organic portion under vascular irritation swells up and first bursts off the enamel. The inorganic portion of the dentine is then shed, leaving the familiar glassy smooth surface. He bases his theory on certain ingenious experiments, an account of which will be found in the paper.

Treatment.—If the view advocated by those observers who regard the labial glands as the cause is to be accepted, the treatment indicated would be removal or destruction of the inflamed mucous glands or correction of their morbid secretion. The former plan is stated by Mr. Royston[1] to give excellent results. For this purpose he recommends nitrate of silver. He states that he has tested the theory many times by treating all the eroded teeth in a mouth with the exception of one or two. The cases were watched for several months to see the difference in the progress of the disease, and almost without exception the untreated erosions distinctly progressed whilst the treated ones remained stationary. Where the condition is extensive an anti-gouty treatment should be tried. The condition can certainly be retarded and the hypersensitiveness of the dentine alleviated by the regular use of milk of magnesia (see p. 278).

Tooth powders should be avoided and a soap with a soft brush used for cleansing purposes.

If the eroded spots are painful, they may be touched with phosphoric acid, chloride of zinc, or, if in a place which does not show, nitrate of silver may be used; or a paint may be prescribed, the patient being instructed to dry the tooth and paint on the solution, keeping the tooth dry to allow the material to harden. The following will be found useful:—

℞	Gum-mastic (powder)	ʒj.
	Chloroform	℥ss.
	Zinc chloride	♏v.
Mix.	To be used as a paint.	

The restoration of the lost tissue by filling or inlays may under certain conditions be carried out.

(B) ATTRITION.

Attrition is a wearing away of the tooth substance, caused by the grinding of one tooth surface on another. It is seen more

[1] *Dental Record*, 1900.

frequently in the teeth of the old, and in the deciduous teeth. The amount of attrition depends to a great extent upon the character of the food, the density of the tooth substance, and the articulation. The surfaces of all the teeth may be affected, or only one or two teeth may be attacked. When localised to one or two teeth the attrition is generally due to some irregularity of the bite. The case shown in fig. 459 is a good example. The attrition is attributable to an irregularity of the maxillary central incisors, their mesial angles impinging upon the mandibular central incisors.

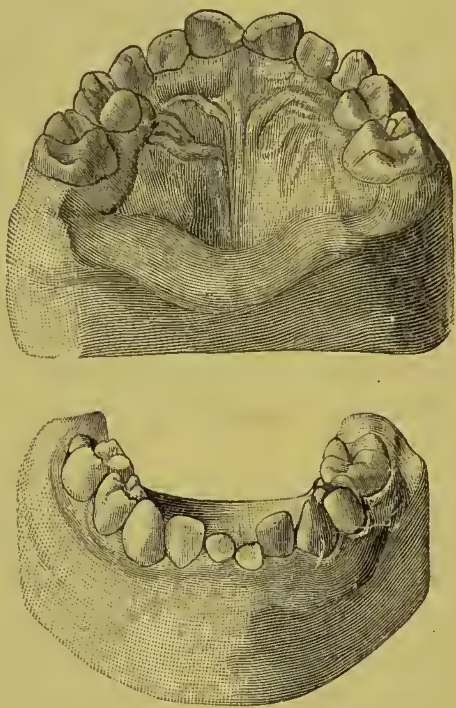

Fig. 459.

Broca has suggested the recognition of four degrees of wear :—

In the first, the enamel alone is worn without any obliteration of the cusps.

In the second degree, the tubercles of the crown have disappeared, and the dentine is exposed.

In the third degree of wear, the height of the tooth is still further reduced, while in the fourth, the wear has extended to the neck, the crown having entirely disappeared, and either the pulp-cavities are invaded or barriers of adventitious dentine have formed.

Attrition in civilised races is always more marked in those of

gouty diathesis. **Examined microscopically**, the dentinal tubes are seen to end abruptly upon the worn surface, while the pulp chamber shows the formation of adventitious dentine which does not always keep pace with the destructive process.

Fig. 460.—Mandibular first molar, showing attrition.

Fig. 461.—Mandibular first molar, showing attrition which is more marked on the posterior aspect than the anterior.

Fig. 462.—Maxillary central incisor, showing well marked attrition on palatal aspect.

Treatment.—In the majority of cases treatment is not necessary. In those where the posterior teeth are absent, and the anterior ones are being worn away through bearing the brunt of mastication, dentures should be inserted and arranged in such a way that the bite is taken off the anterior teeth. If the patient refuses to submit to dentures, the progress of the destruction can be arrested by filling the cavities with metal, bringing the filling over the edges of the enamel in such a way that in occlusion the fillings come in contact and so arrest the progress of tooth destruction. This treatment is effectual, but the appearance produced is somewhat unsightly.

The hypersensitiveness of dentine which at times accompanies rapid attrition should be treated as indicated on page 361.

(C) ABRASION.

By **abrasion** is understood destruction of the tooth substance through friction from a foreign body, such as a denture, pipe, or tooth-

brush. Abrasion is more likely to be mistaken for erosion than for attrition. It may occur on nearly any tooth, and is very frequently caused by the presence of a clasp. It is the cause of most of the V-shaped cavities seen upon the anterior teeth near the gum margin.

These cavities are mostly found upon the maxillary canines and the mandibular canines and first premolars, their presence in these positions being probably due to the fact that these teeth are the prominent parts of the curves of the arch, and therefore more likely to be affected. Again, this condition is at times more marked upon the left than the right side, probably from the tooth-brush being used transversely, and from the fact that in a right-

FIG. 463.—Maxillary canine, showing abrasion from a wire attached to an upper denture.

FIG. 464.—Maxillary central, showing abrasion from a wire attached to an upper denture.

handed person more force would be applied in cleaning the left than the right side. That this seems to be the explanation is shown by a case of a left-handed patient who came under notice, the destruction of the teeth being more marked upon the right side than the left. In support of the view that the tooth-brush used transversely aids the destruction of the tooth substance, another case may be mentioned in which, by accident, the left maxillary central incisor had been completely dislocated and subsequently replaced by the patient, but unfortunately had slightly elongated and become fixed in a position anterior to the approximal teeth. This tooth, with the right maxillary central and both lateral incisors, was attacked by the V-shaped destruction, the point of interest being that the prominent incisor was much more damaged than the adjacent teeth, and when a suitable instrument was placed along the apices of the depressions it was found to be

on the same level. Abrasion, like erosion and attrition, is more marked in gouty patients.

Treatment. — If the abrasion is slight, treatment should be directed to removing the cause. When due to friction from the tooth-brush, the directions for the treatment of erosion with regard to powders, &c., should be carried out. Hypersensitiveness of the dentine, if present, must also be treated. If the abrasion is advanced, the cavities formed should be filled with either amalgam or gold.

CHAPTER X.

Diseases of the Dental Pulp.

(A) INJURIES OF THE PULP.

(1) RUPTURE OF THE APICAL VESSELS.

This occurs in dislocation of the teeth. The effect on the pulp depends on the severity of the dislocation. With slight dislocation the rupture of the vessels may not be complete, and if the tooth is replaced, complete regeneration of the tissues occasionally occurs and the pulp retains its vitality and functions. More frequently thrombosis of the arteries supervenes and dry gangrene of the pulp follows. With complete dislocation, union of the apical vessels may take place if the tooth is replaced, but this is rare. In a case recorded by Mr. A. S. Underwood,[1] whilst performing immediate torsion on a superior lateral incisor, the tooth was completely dislocated and fell on the floor. It was sterilised and replaced. Two years afterwards the tooth responded to thermal changes and showed no degenerative changes. In complete dislocation, if the tooth is replaced with the pulp still present, dry gangrene may occur if the parts have been thoroughly sterilised.

(2) LACERATION OF THE PULP TISSUE.

This may occur in the preparation of a cavity. If the injury is slight, and strict antiseptic precautions are taken in "capping" the pulp, the local inflammation started by the injury subsides and the pulp retains its vitality. Pulps which have been capped frequently undergo fatty degeneration. This occurs more frequently in attempts to save septic pulps and is probably due to the action of bacterial toxines. Laceration of the pulp tissue accompanying fracture of the tooth generally results in loss of the organ by

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[1] *Trans. Odont. Soc.*, vol. xviii., p. 98.

inflammation. When the pulp is exposed the wounded surface becomes septic, while in cases high up in the root and not exposed, the constant movement of the fractured portion causes the primary inflammation started by the injury to continue and so leads to destruction of the pulp. A lacerated pulp may undergo a process of healing by calcification. In one case mentioned by Mr. Tomes a patient had a maxillary molar fractured through the pulp chamber. Previous to the operation the patient had suffered pain, but the pain disappeared after the attempt at extraction. A few months afterwards the tooth was removed, and it was seen that a mass of calcified tissue not only projected from the pulp chamber, but also hung over and concealed the margin of the carious cavity. A similar case of calcification is also narrated by Black.

(B) HYPERÆMIA.

This condition is analogous to active or arterial hyperæmia occurring in other parts of the body.

Causes.—When the dentine and cementum are not exposed, hyperæmia can only be produced by thermal changes. When the dentine or the cementum is exposed by caries, erosion, attrition, &c., a variety of other causes may come into action, such as sweet, acid, and sour substances, friction from bands on plates, &c.

Pathology and morbid anatomy.—The hyperæmia is usually of an intermittent character. The irritation produced by the thermal changes probably causes a partial inhibition of the vaso-motor nerves and so leads to a dilatation of the vessels. The effects of an intermittent hyperæmia on the pulp are—

(i.) The formation of secondary dentine.

(ii.) The production of degenerative changes, fibroid and calcareous.

The hyperæmia may be continuous (*acute*), especially when the surface of dentine exposed is large and the tissue much reduced in thickness, as seen in advanced caries or attrition. Acute hyperæmia (the cause of which is obscure) is occasionally seen in sound teeth. Acute hyperæmia usually terminates in inflammation.

Microscopical appearances.—A section of a pulp in a state of hyperæmia will show—

(1) The vessels dilated and tortuous, with varicosities at certain points, especially if the condition is acute.

(2) An increase in the number of pulp cells.

(3) Collections of red blood corpuscles amongst the pulp cells.

Symptoms.—The symptoms depend on the amount of hyperæmia. The patient may complain of only slight discomfort on taking hot or cold fluids, &c. The pain, however, may be of a lancinating character, while in severe cases the slightest irritation will start an acute paroxysm of pain which may last for hours. The tooth will also be tender to the slightest touch, owing to extension of the hyperæmia to the periodontal membrane.

Treatment.—When due to exposure of the dentine through caries, the cavity must be cleared and the floor lined with a mixture of oxysulphate of zinc and a sedative, such as oil of cloves, the cavity being completed with an oxyphosphate cement. A strong application of some counter-irritant should be applied to the gum. When the tooth is extremely sensitive it is not always possible to thoroughly prepare the cavity. Under this condition a dressing of oil of cloves, creosote, &c., covered with cotton wool and sandarach varnish, may be inserted for two or three days, at the end of which period it will, in all probability, be possible to prepare and fill the cavity permanently.

If the case does not yield to this treatment, the pulp should be exposed under an anæsthetic and subsequently devitalised. Cases of hyperæmia due to exposure of dentine or cementum, erosion, attrition, abrasion, recession of the gums, injury, &c., are dealt with in the treatment of those conditions.

In patients suffering from acute hyperæmia where the enamel is intact, strong application of counter-irritants should be applied to the gum. If this fails to bring relief, the pulp may be exposed under an anæsthetic and removed. Where the pain has been severe and the patient is considerably reduced in strength, extraction is often the wiser and better course.

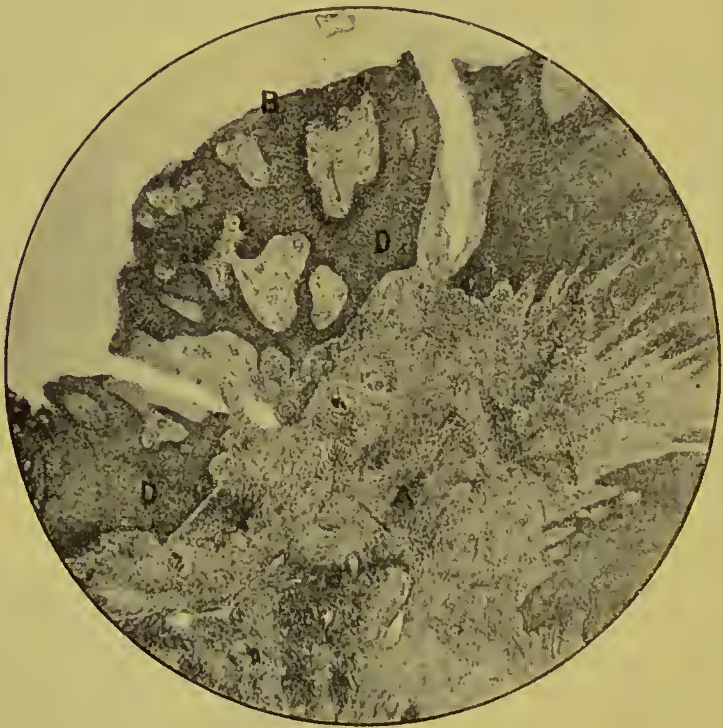
(C) PULPITIS.

(1) ACUTE.

The changes which take place during inflammation in the pulp are the same as those observed in other tissues. The inflammation is nearly always infective, but it may be simple. It is said by some authors to terminate occasionally in resolution. The most frequent termination is suppuration, and in cases where the condition is very

FIG. 465.—From "Dental Microscopy," by Hopewell Smith. Inflammation and suppuration of the pulp, vertical section (× 45). (*a*) Dentine; (*b*) pulp tissue; (*c*) odontoblasts multiplied in size and number; (*d*) basal layer of Weil; (*e*) micrococci in dentinal tubules; (*f*) liquefaction foci; (*g*) carious cavity in dentine; (*h*) fibrillar adventitious dentine; (*i*) degenerate odontoblasts; (*j*) artery; (*k*) vein; (*l*) inflammatory cells and products; (*m*) abscess cavity; (*n*) fibrification of cells.

acute "gangrene" may occur. The reasons that acute pulpitis so commonly terminates in suppuration are that the delicate nature of the tissue of the pulp is unable to withstand an inflammation of any severity, and that this tissue being practically in an enclosed bony cavity the pressure from the inflammatory products is far more destructive to its vitality than if it were not thus confined.



× 40.

FIG. 466.—Productive pulpitis. Longitudinal section. A, granulation tissue of pulp; B, epithelial surface; C, simple and compound papillæ. D, columns of epithelial cells extending deeply into the growth.

Gangrene of the pulp is stated by Arkovy[1] to be due to a specific organism to which he has given the name bacillus gangrenæ pulpæ. This organism he finds the most prominent, if not the only factor in wound-gangrene.

Causes.—Exposure or infection of the pulp from caries is by far the most common cause of acute pulpitis. It may arise from spread of inflammation from the periodontal membrane. Other causes are,

[1] *Vierteljahrsschrift für Zahnheilkunde*, April and July, 1898.

injury during the preparation and filling of cavities, and the incautious use of arsenious acid for obtunding sensitive dentine. It may be a sequel to hyperæmia.

Symptoms.—The symptoms of acute pulpitis are pathognomonic—sharp shooting pain, often of a throbbing character, which is generally more severe at night when the patient assumes the horizontal position. Thermal changes also lead to severe paroxysms of pain, although in the early stages of acute inflammation cold produces relief by constricting the blood-vessels. It is at times difficult to discriminate inflammation from hyperæmia. With the latter, however, the throbbing character of the pain is not so well marked, and the pulp is usually not exposed. Acute pulpitis must also be distinguished from acute periodontitis, and the main points of difference are briefly as follows :—

Acute Pulpitis.	Acute Periodontitis.
Pain sharp, throbbing, or lancinating — intermittent and reflected.	Pain dull, heavy, and constant.
Thermal changes to the teeth cause pain.	Thermal changes do not cause pain.
Pressure or tapping on the tooth causes no pain.	Pressure or tapping on the tooth causes pain.
Slight pressure on a piece of cotton-wool in the cavity generally causes acute pain.	Slight pressure on a piece of cotton-wool in cavity does not cause pain, except through pressure transmitted to the periosteum.

Attention to these points will assist in diagnosis, but it must not be forgotten that with acute inflammation of the pulp there is at times a slight inflammation of the periosteum through continuity.

Treatment.—This consists in devitalisation. The pain in acute pulpitis can be temporarily relieved by the application of strong carbolic acid, creosote, oil of cloves, &c.

(2) CHRONIC.

Chronic pulpitis may be :—(*a*) Suppurative ; (*b*) Productive ; or (*c*) may lead to degenerative changes, fibroid and calcareous.

(*a*) **Suppurative chronic pulpitis.**—The usual condition is for the suppuration to commence at the portion of the pulp exposed by

caries. The ulceration spreads at a varying rate until the whole of the pulp tissue is completely destroyed. In a few instances chronic suppurative pulpitis may occur in teeth where the pulp chamber is intact. Cases of this character have been recorded by Hugenschmidt.

Symptoms.—Suppuration may occur without any pain. Usually in the early stages there is pain to thermal changes. In the later stages, however, cold gives a certain amount of relief, while heat causes intense paroxysms of pain. This symptom of **increased pain to heat is almost diagnostic of a suppurating pulp.** As the suppuration approaches the apex, the inflammation spreads to the periodontal membrane and symptoms of inflammation of that tissue appear. Pain is more marked during the night than during the day, and is very likely to become wandering in character. It may be referred to another tooth or to other parts of the body (see chapter XVIII.). In exposed cavities there will usually be pain during mastication. When the pus is confined, for instance in suppurative pulpitis under a filling, the pain may be intense. It is usually constant in character with acute exacerbation on the application of heat to the tooth. Opening the pulp chamber in these cases gives nearly instant relief.

Treatment.—The pulp must be laid bare by removing any filling, carious dentine, &c. The surface should then be washed with an antiseptic solution with a view of destroying the micro-organisms present. The pulp should then be devitalised.

(*b*) **Productive pulpitis.**—In this condition a large amount of granulation tissue is formed. If there is free access between the pulp cavity and the carious cavity, the granulation tissue encroaches upon the latter, forming a fleshy-like tumour which if exposed to injury during mastication may ulcerate. In cases where the pulp is more confined the pressure of the inflammatory products may lead to marked absorption of the tooth structure. The granulation tissue may be replaced by fibrous or by calcified tissues. When replaced by the former the usual microscopical appearances are as follows :—

The fleshy-like mass is composed principally of granulation tissue, with a tendency to develop into fibrous tissue. The surface is often covered with a layer, or several layers, of squamous epithelium (fig. 466), probably due to a kind of skin grafting, a small piece of epithelial tissue no doubt having been conveyed to the surface of the pulp during the process of mastication.

FIG. 467.—Productive pulpitis (longitudinal section) highly magnified. (*a*) Fibrous stroma ; (*b*) large granular cells (no capillaries visible).

FIG. 468.—Showing pulp of a mandibular incisor containing a large number of calcareous deposits. (*a* and *b*) Normal dentine ; (*c*) pulp nodule ; (*d*) dentine containing very irregularly arranged tubes ; (*e*) pulp ; (*f*) cementum.

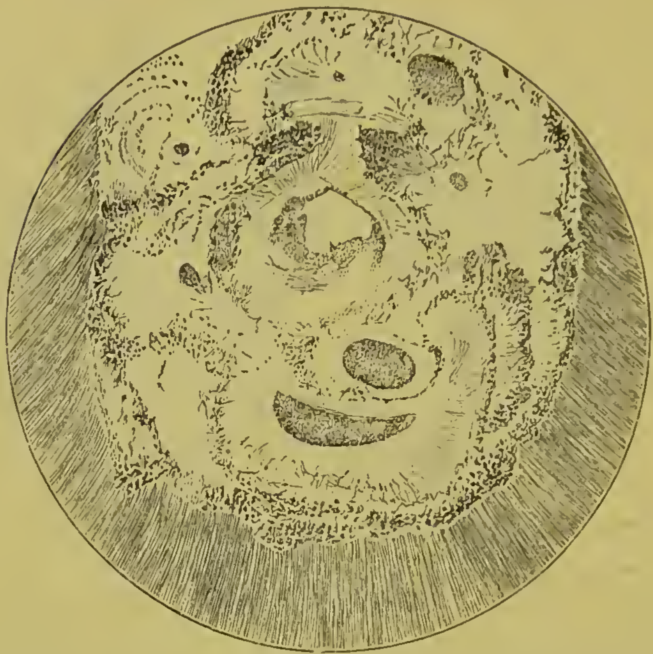


FIG. 469.—To show "osteodentine" variety of new dentine. From a specimen in the possession of Mr. Douglas Caush.

FIG. 470.

The microscopical characters of a pulpitis ending in the formation of calcified tissues vary :—

In the case shown in fig. 468 there has been a localised chronic pulpitis which has led to marked absorption of the dentine. Calcification is here taking place in the form of nodules of dentine.

In the section shown in fig. 469 a tissue of "osteodentine" variety has been formed. Under rare conditions true bone may be formed. This was first noted by Salter.[1] The specimen figured by him is shown in fig. 470.

FIG. 471.—Showing bone in dentine.

A remarkable case of this character came under the notice of Mr. Ackery.[2] The tooth in question was a maxillary premolar which had only partly erupted and the root of which was only half formed. The inflammatory process had caused extensive excavation of the dentine, which had been replaced by well-formed bone (see fig. 471).

[1] "Dental Pathology and Surgery," p. 80.

[2] For a full account of this case see *Transactions of the Odontological Society*, vol. xxv., p. 66.

Symptoms.—In the early stages there will be pain to thermal changes. If the new tissue formed is fibrous in character sensitiveness will be to a great extent absent owing to the non-development of nerve fibres, but pain may be produced by transmission of force to the nerves in the normal pulp. Where calcification has taken place, but is slight in amount, the pulp will respond to thermal influences, but with the development of a large amount of tissue the pain becomes lessened.

Productive pulpitis which has encroached on the carious cavity and is fibrous in character must be diagnosed from localised hypertrophies of the muco-periosteum.

The points of difference are: In the former, absence of pain to pressure, and no great liability to hæmorrhage; in the latter, extreme sensitiveness to pressure and liability to hæmorrhage on slight injury. A careful examination will show the one springing from the pulp chamber and the other from the gum around the neck of the tooth.

Treatment.—The excess tissue should be first scraped away, the hæmorrhage which ensues arrested, and the pulp devitalised. If calcification has occurred, but is slight, devitalisation may be practised. If calcification is extensive, mummification of the pulp may be tried.

(D) DEGENERATIONS.

(1) FATTY.

This is usually seen in the pulps of senile teeth, and in those which have been treated with a view to retaining the pulp alive. To the naked eye the pulp is diminished in volume and is of a pale reddish-grey colour with traces of yellow. In other instances it is of a cheesy-like consistency, while in very advanced conditions a soft greasy mass only is present in the pulp chamber. According to Wedl this mass is composed merely of a dirty brownish-yellow detritus, with traces of a fibrous structure, together with clusters of stellate fatty-acid crystals.

In pulps which are the subject of fatty degeneration reaction to thermal stimuli is much diminished and in advanced cases quite lost.

Microscopical appearances.—The odontoblasts appear degenerated and form a layer upon the surface of the pulp. The paren-

chyma of the pulp contains fat globules which form chains and follow the course of the vessels and nerves. The medullary sheath of the nerves and walls of the vessels also undergo degeneration.

Treatment.—Removal of the pulp and subsequently filling of the pulp canals.

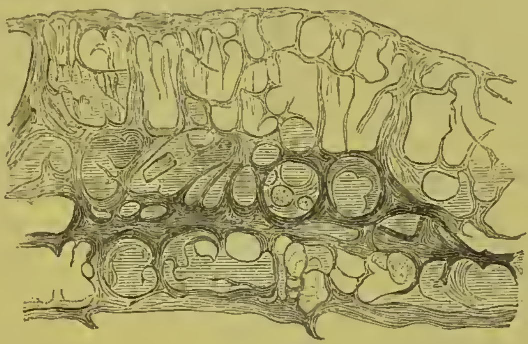


Fig. 472 (Wedl).

Fig. 473 (Wedl).

(2) FIBROID.

This occurs in the pulps of senile teeth, and in pulps which have been the seat of intermittent hyperæmia or a low grade of chronic inflammation. The normal cell elements of the pulp are replaced by fibrous tissue. This condition was first described by

Wedl.[1] To the naked eye the pulps appear flattened and shrivelled and are often brittle in consistency. The colour is grey-yellow or reddish-brown according as it contains a smaller or larger amount of necrotic blood.

Microscopical appearances.—**Under low magnifying powers** a superficial reticular network is seen, at the edges of which the odontoblasts appear shrunken, while, if the atrophy is far advanced, they will have disappeared. The blood vessels appear larger than usual and have thin walls, so that it is impossible to distinguish between arteries and veins. The nuclei in the sheath have also disappeared. The vessels are seen to take an irregular course and to freely intertwine, marked constrictions due to the contraction of the connective tissue trabeculæ being present in places. **Under higher powers** (300 diameters) the network becomes more plainly visible, the bundles of tissue interlacing and forming alveolar-like spaces, the central ones corresponding to the shrunken blood vessels. The nerve sheaths are fatty, granular, and in places covered with small concretions of lime. In various places staining is seen. The staining arises from the colouring matter of the blood. Calcareous deposits of round, elliptical, cylindrical shapes are also seen in the tissue of the pulp (figs. 472 and 473).

In a communication to the *Journal of the British Dental Association* for March, 1892, Mr. Hopewell Smith described and figured a case of this character in which the fibroid degeneration was complete, the cellular elements of the pulp being totally absent. Sections are shown in figs. 474 and 475.

(3) CALCAREOUS.

This form of degeneration is likely to follow intermittent hyperæmia or inflammation of the pulp and is very prone to attack the teeth of patients of a gouty diathesis. Calcareous deposits are occasionally met with in apparently healthy pulps, and it is doubtful if they are, in such cases, of pathological significance. Calcareous degeneration must be carefully distinguished from adventitious dentine, that is, the addition of fresh dentine to the original boundaries of the pulp chamber.

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[1] "The Pathology of the Teeth," p. 237.

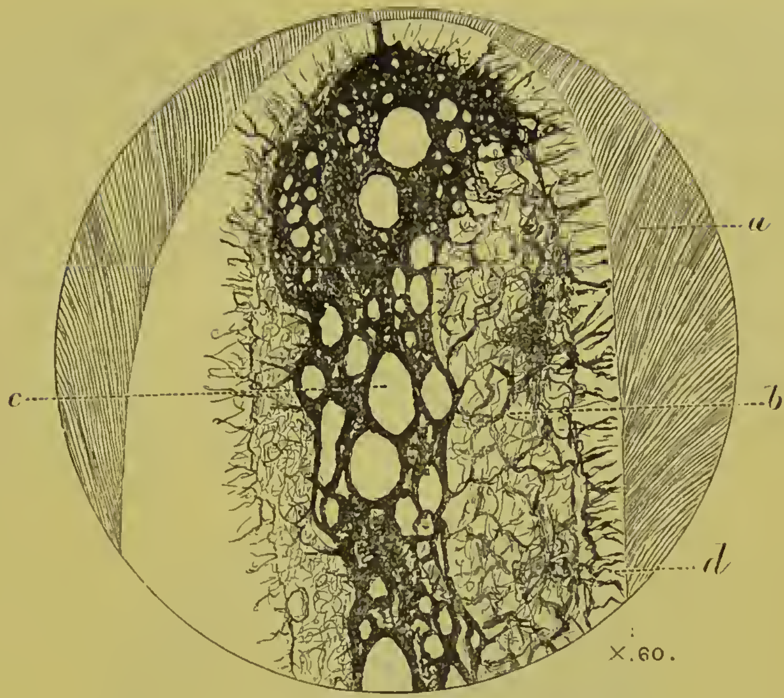


FIG. 474.—(Transverse section). (*a*) Dentine (*b*) reticular pulp tissue; (*c*) areolæ; (*d*) degenerate odontoblasts.

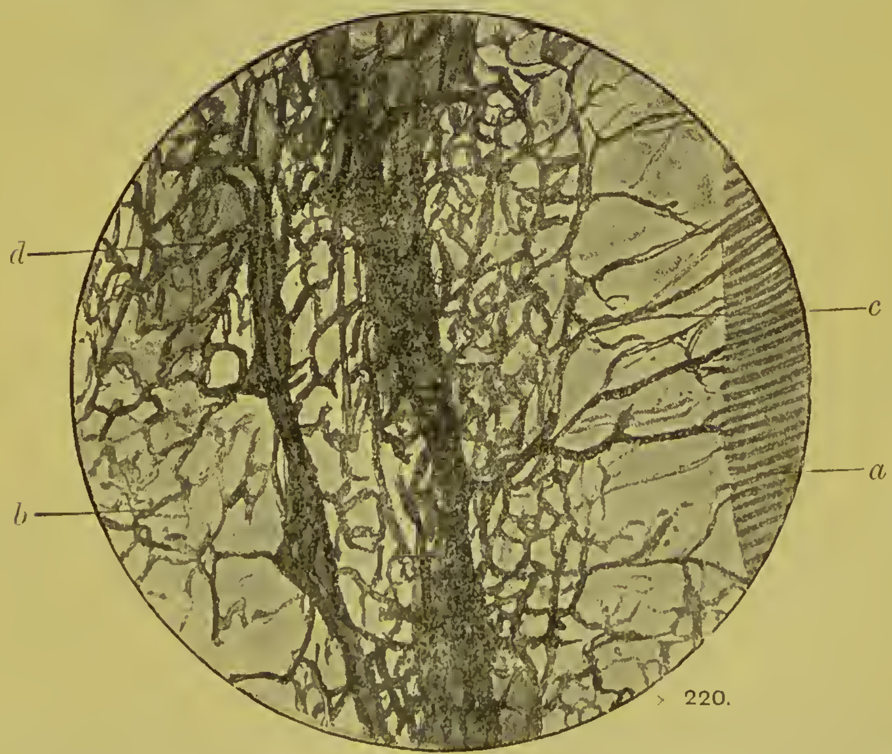


FIG. 475.—(Longitudinal section). (*a*) Dentine; (*b*) reticular pulp tissue; (*c*) degenerate odontoblasts; (*d*) fibrous cylinder.

The simplest form of calcareous deposit is a small pulp nodule. On examination of the tooth after its extraction, these nodules are just visible to the naked eye, and under a low magnifying power are seen to be concentrically laminated ; in some not fully calcified the central portion presents an irregular appearance. Pulp nodules are formed near the periphery of the pulp, and though developed in its tissue, eventually become included in any secondary dentine that may be formed, the dentinal tubes bending round the nodule. Fig. 476 represents two small pulp nodules from the tooth of a child fourteen years old, which was removed for irregularity. In fig. 477 the pulp nodule is seen to be projecting from the wall of the

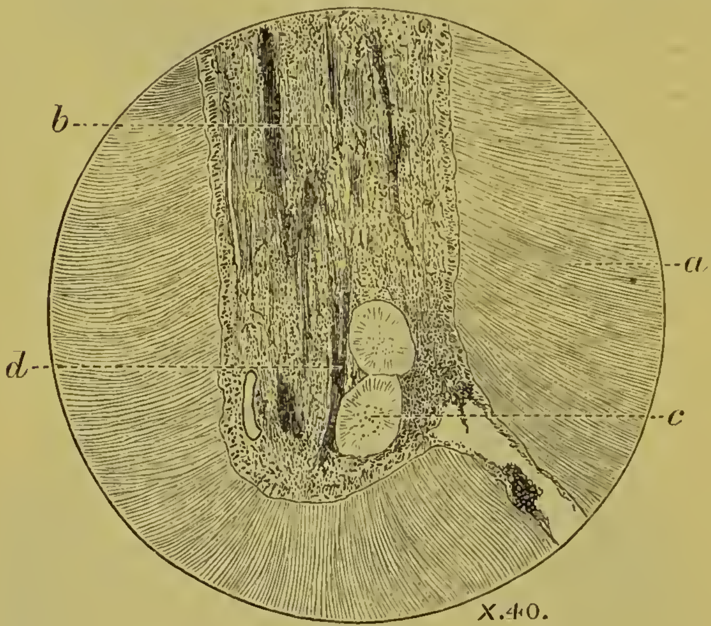


FIG. 476.—Pulp nodules (longitudinal section). (*a*) Dentine; (*b*) normal pulp tissue ; (*c*) pulp nodules ; (*d*) nerve bundles.

canal, having become enclosed by the new formation of dentine. In the coronal pulp of the molars, the nodules reach a much larger size, and viewed under a very low magnifying power are seen to be lobulated in outline ; on section many are apparently composed of a number of small nodules joined together by a structureless material (fig. 478). These pulp nodules occur amongst the tissues of the pulp, and must be differentiated from calcification of the tissues of the pulp. Dr. Black considers that the deposits of calcoglobulin bear some relation to the formation of pulp nodules.

A curious form of calcareous degeneration is frequently seen in the roots of molars. To the naked eye the pulp is stiff, retaining its shape when removed from the canals and resuming its shape after

FIG. 477.—Pulp nodule fixed to wall of cavity. (*a*) Pulp nodule; (*b*) dentine; (*c*) bent tubes of dentine; (*d*) soft tissue adherent to specimen.

FIG. 478.—Semi-diagrammatic.

being bent. To the touch the pulp feels gritty; under the microscope it is found to be fibrous in character, the cellular elements having to a great extent disappeared, while lying parallel with the

fibres and attached to them, are little cylinders of calcareous material (fig. 479). In advanced stages the cylinders coalesce, being jointed in an irregular manner. Under such conditions there is an obliteration of the cells, nuclei and connective tissue of the pulp. According to Salter and Black this condition is to be regarded as a marked sign of degeneration, and is mostly met with in the teeth of the old.

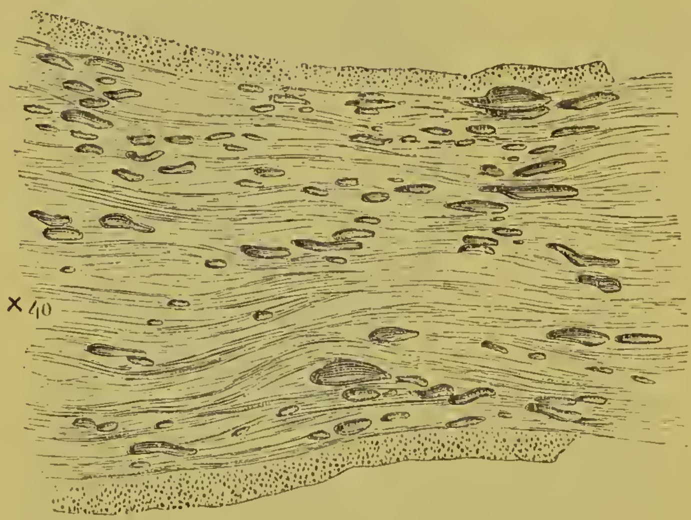


FIG. 479.

FIG. 480.—(*a*) Calcified pulp.

The whole tissue of the pulp may undergo calcification.—To the naked eye the deposit differs from the pulp nodule in being non-nodulated. It is, as a rule, regular in outline and presents a smooth surface. Microscopically the appearances vary. In some, the calcified tissue element of the pulp is apparent, others appear granular on section with a few irregular tubes scattered here and there, while others exhibit virtually no structure at all.

(E) THE PROTECTIVE ACTION OF THE PULP.

When from any cause, such as caries, erosion, &c., the safety of the pulp is threatened, a formative activity occurs leading to the production of new tissue in the road of the threatening trouble. This new tissue has been termed "**adventitious dentine**" by Mr. Hopewell Smith (see *Trans. Odonto. Soc.*, vol. xxix., New Series). It is situated at the pulp end of the dentinal fibrils which are the seat of irritation (see fig. 481). It is interesting to note that the original dentine which contains these fibrils is difficult to stain, and appears more calcified than other portions of the tooth.

FIG. 481.

The structure of adventitious dentine varies considerably under different circumstances, and the variation is probably dependent to a great extent upon the rapidity of formation. Thus, **five varieties** have been observed and described (see *Trans. Third International Dental Congress*, Paris, 1900). These are known as **areolar, cellular, fibrillar, hyaline and laminar** adventitious dentines. The first named is the commonest variety and the least frequently found is the hyaline—a clear, homogeneous, structureless deposit of dentine closely resembling the ground-glass-like matrix

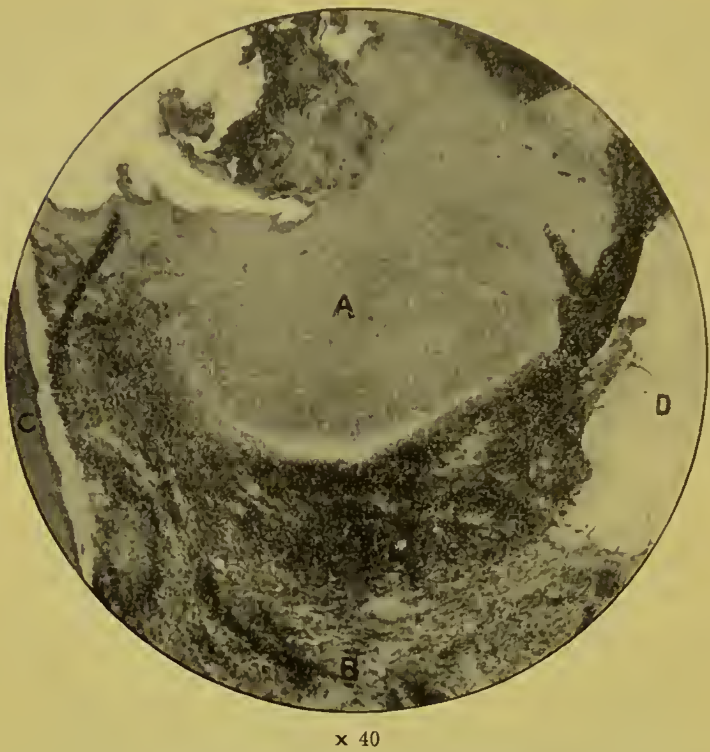


FIG. 482.—Photo-micrograph by Mr. Hopewell Smith. Hyaline adventitious dentine. (A) Ground-glass-like dentine; (B) chronic pulpitis; (C) primary dentine; (D) abscess cavity.

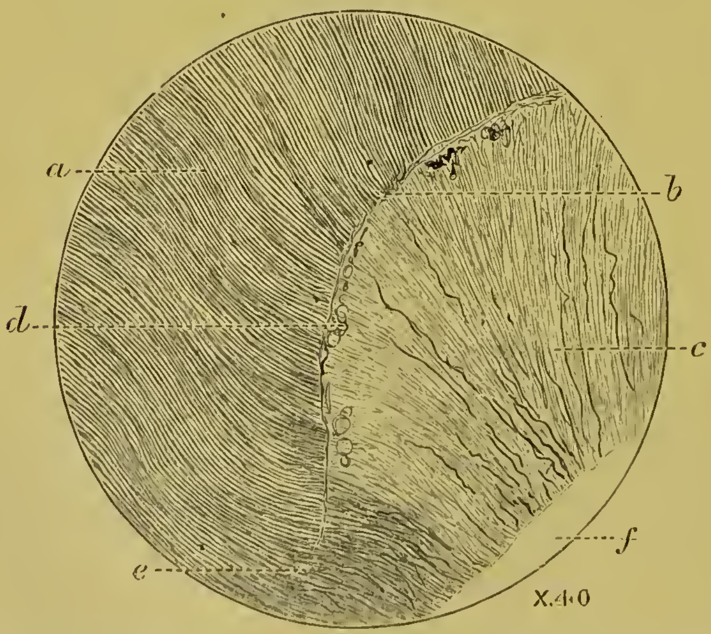


FIG. 483.—(Longitudinal section). (*a*) Normal dentine; (*b*) limit of original chamber and line of demarcation; (*c*) fine-tubed, but regular, section of dentine; (*d*) group of interglobular spaces; (*e*) at *e* tubules intermingle freely; (*f*) pulp chamber.

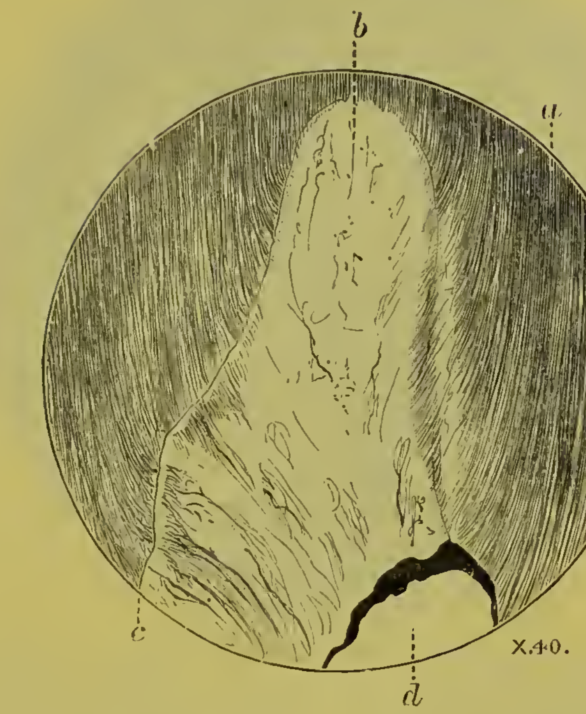


FIG. 484.—Adventitious dentine containing but few tubes. (a) Normal dentine (b) adventitious dentine tubes are few and very fine; (c) line of demarcation ; (d) pulp chamber.

FIG. 485. Areolar adventitious dentine. (a) Carious dentine; (b) inter-globular spaces; (c) pulp cavity; (d) newly-formed and irregular-tubed dentine.

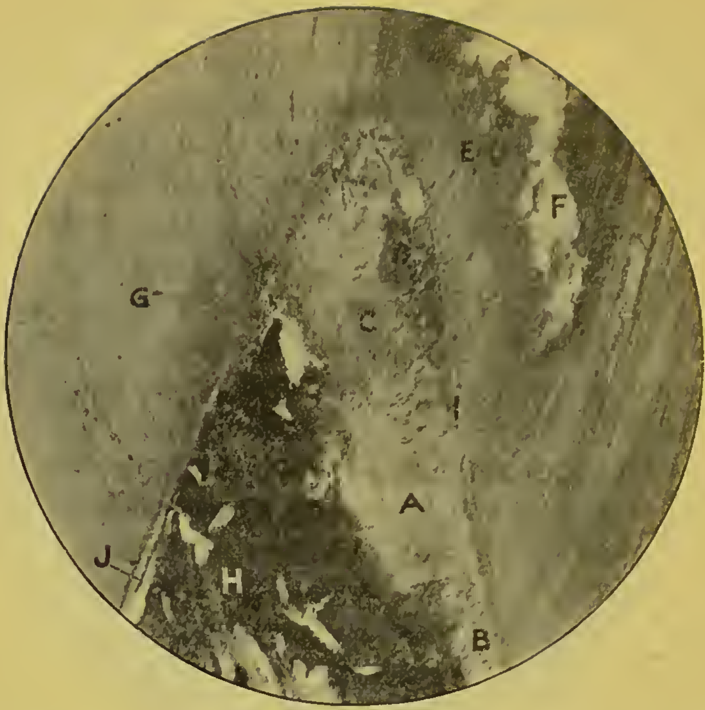
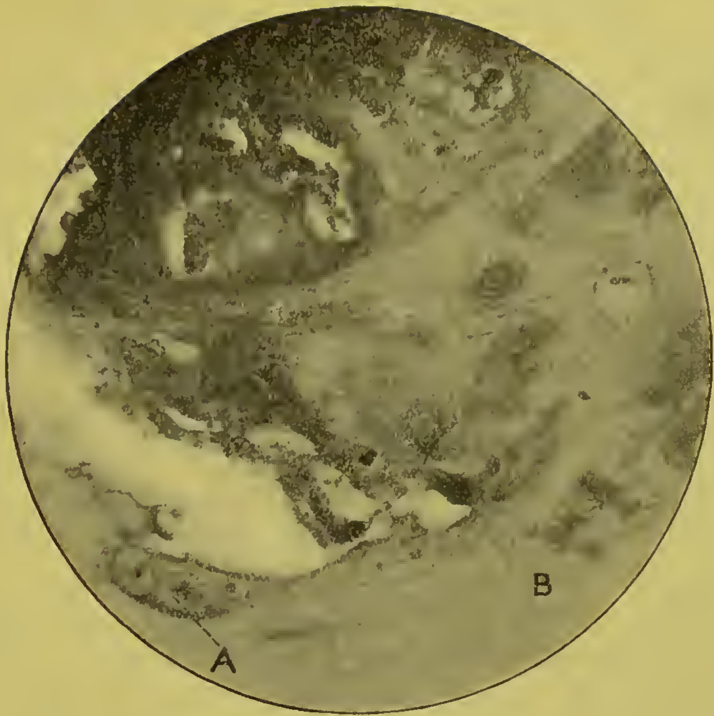


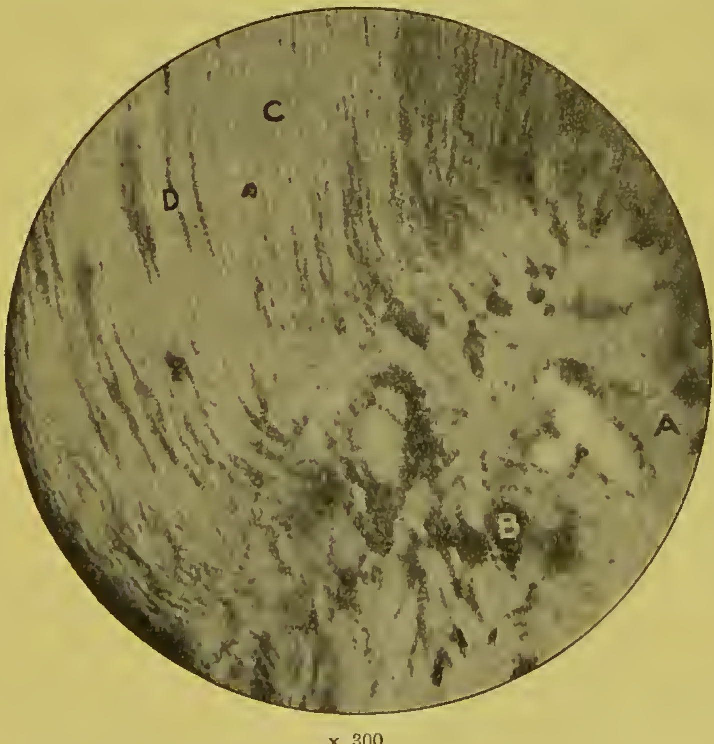
Fig. 486.—Photo-micrograph by Mr. Hopewell Smith. Areolar and fibrillar adventitious dentine. (A) Adventitious dentine with areolar structure at B and fibrillar at C, which at D is infected with micro-organisms from caries at E; (F) carious cavity; (G) primary dentine; (H) hyperæmic pulp tissue; (I) junction of primary and adventitious dentine; (J) layer of odontoblasts.

Fig. 487.—Photo-micrograph by Mr. Hopewell Smith. Laminar adventitious dentine. (A) Laminar dentine; (B) cellular dentine; (C) chronic pulpitis; (D) primary dentine.



× 250

FIG. 488.—Photo-micrograph by Mr. Hopewell Smith. Cellular adventitious dentine. (A) Encapsuled cells with nuclei ; (B) structureless matrix.



× 300

FIG. 489.—Photo-micrograph by Mr. Hopewell Smith. Adventitious dentine infected by micro-organisms from the primary dentine. (A) Adventitious dentine ; (B) masses of micro-organisms ; (C) primary dentine ; (D) carious dentine.

Laminar adventitious dentine is commonly associated with productive inflammation of the pulp. Its structure is shown in fig. 487. Fig. 488 shows the cellular variety of adventitious dentine, and fig. 482 the hyaline. In the fibrillar forms the tissue may approximate to normal fine-tubed dentine. A slight, abrupt bend of the tubes is all that marks the junction of the two tissues. In many specimens the tubes, however, are not quite so regular and plentiful as in normal dentine, but the boundary line between the normal and the new dentine is generally well marked. Fig. 483 is from a deciduous molar retained until the age of 35. More commonly a few fibres are seen continued from the ordinary dentine, and these, instead of traversing through the whole thickness of the new deposit, end in fine pointed extremities (fig. 484).

The areolar variety contains a large number of interglobular spaces and seems to occur when the new tissue has been formed rapidly as the result of acute caries (figs. 485 and 486).

In fig. 489 the carious process has commenced in the new dentine, showing that micro-organisms quickly infect the newly-laid-down tissue.

CHAPTER XI.

Operations Connected with the Pulp and Pulp Canals.

(A) WHEN THE PULP IS NOT EXPOSED.

In deep cavities where it is intended to insert a metallic filling, the floor should be covered with a layer of non-conducting material such as oxy-phosphate of zinc. If during the progress of caries the pulp has shown signs of irritation, oxy-sulphate of zinc should be used in preference to the oxy-phosphate. If the layer of dentine between the cavity and the pulp is very thin the following should be the procedure :—The cavity, having been freed of all foreign matter, should be swabbed with a 2 per cent. solution of perchloride of mercury in absolute alcohol; the mercury acts as an antiseptic and the alcohol as a dehydrant. With a blast of warm air the cavity should be thoroughly dried and the floor lined with a layer of oxy-sulphate of zinc.

(B) WHEN THE PULP IS EXPOSED AND LIVING.

(1) THE OPERATION OF "CAPPING."

In performing this operation attention must be paid to the following points:—(*a*) To render the parts thoroughly aseptic; (*b*) to use a cap of non-irritant material; (*c*) to insure juxtaposition between the cap and its contents and the pulp; (*d*) to avoid pressure upon the pulp; (*e*) to prevent the conduction of thermal changes to the pulp.

The best mode of procedure in capping is as follows :—Stop all bleeding from the pulp by syringing with hot water, swab out the cavity with a solution of corrosive sublimate 1 in 1000, and carefully dry the cavity. Mix a thin paste of the powder of the oxy-sulphate of zinc and oil of cloves, introduce it into the concave side of the

cap, and place it in position over the exposed pulp, taking care that the margin of the cap rests upon the dentine and not on any part of the exposed pulp. Hold the cap in position with an instrument until it is fixed, then fill the cavity with gutta percha or some osteoplastic filling. The cap employed may be made of any of the following materials—tin, platinum, lead, ivory, vulcanite. These caps are sold ready made by the depôts, but they can be easily constructed by cutting out with scissors a circular piece of the material used, and giving it a "cup-shape" by pressing upon it with the butt end of an excavator. At times it is very difficult to get the cap into position, especially with the conveying forceps. The difficulty may be overcome by punching a small hole in the cap, so that the little flap formed by punching will be on the convex side of the cap, and if this flap is held with the conveying forceps the cap may be easily conveyed to the cavity and kept in position. The flap will resume its place with the slight pressure used in filling the remainder of the cavity.

(2) DEVITALISATION OF THE PULP.

This operation may be considered under the following heads:—

(*a*) Application of the drug.
(*b*) Opening up the canals.
(*c*) Removal of the pulp.
(*d*) Treatment of the pulp canals.
(*e*) Filling the canals.
(*f*) Treatment of difficult canals.

(*a*) **Application of the drug.**—For devitalising the pulp arsenious acid is used, either alone or in combination with other substances. About one-sixteenth of a grain will suffice. The objection to the use of arsenious acid is the pain caused during its action. The pain can be alleviated by employing sedatives with the arsenic and by avoiding pressure on the pulp. The following preparation will be found useful:

℞ Acidi arseniosi
Cocainæ hydrochlor. } ... āā partes æquales.
Acidi carbolici glacialis

Misce, et fiat Pasta.

Two other useful preparations are the devitalising fibre of S.S. White and Co. and Baldock's paste. The mode of application is

as follows:—The cavity is opened up and all *débris* syringed out with warm water. The carious dentine is next removed. It is not always possible to remove all the carious tissue owing to the pain caused, but the portion bordering the edge of the cavity and the part covering the pulp must be removed and a free exposure obtained.

It is important that the pulp should be freely exposed, as the resulting hæmorrhage relieves congestion and prevents discolouration of the dentine. The cavity should next be syringed with warm water, and measures taken to exclude moisture during the subsequent steps. The cavity should then be dried and the pulp and adjacent dentine disinfected. The dressing is next applied in

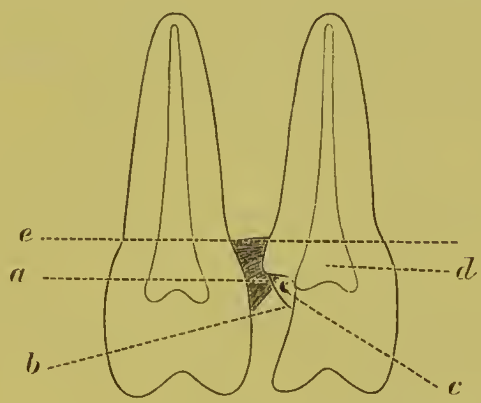


FIG. 490.—(*a*) Gutta-percha; (*b*) metal cap covering dressing; (*c*) dressing of arsenious acid; (*d*) pulp chamber; (*c*) line indicating margin of gum.

close contact to the pulp, and over the dressing a concave cap of metal is placed. The cap should be large enough to cover the dressing without pressure, and to allow the edges to rest on the dentine. The cavity is then sealed with gutta-percha or oxysulphate of zinc.

Some operators use a solution of gum mastic or gum sandarach in preference to the gutta percha, on the supposition that in their application there is less likelihood of shifting the cap and dressing. A great drawback, however, to the use of these gum resins is that they are liable to get under the cap and prevent the action of the arsenious acid. In applying arsenious acid on the approximal surfaces with the cervical margin near the gum, there is a chance of the dressing shifting during the introduction of the filling

material. In such positions it is best to place a rim of gutta percha along the cervical margin first. A small pit will thus be formed and the arsenious acid can then be applied without any risk of the dressing shifting. Fig. 490 explains this point diagrammatically. In cavities in isolated teeth where there is a danger of the dressing not being retained, an elastic band or silk ligature passed round the tooth will be found useful.

Arsenious acid, even with the precautions suggested, may cause great pain during its action, particularly with patients of a gouty or rheumatic type. Counter-irritation to the gum in the form of poultices should be tried. In applying the poultice, contact with the tooth must be avoided. If the poultice is not effective, phenacetin, acetanelid, or antikamnia should be administered. If the pain is intense, morphia may, if necessary, be given.

The time during which an arsenical dressing should remain varies according to the condition of the pulp. In acute inflammation twenty-four hours is usually sufficient; with chronic suppurating pulpitis three to four days, while the dressing may remain for at least a week when a fibroid or calcareous condition of the pulp is present. When used for deciduous molars the arsenical dressing should be applied in the morning and removed in the afternoon. If allowed to remain for twenty-four hours there is always a liability of periodontal complications.

The action of arsenic upon the pulp has been studied by Dr. Arkovy.[1] His conclusions are as follows:—

"1. As_2O_3 brought into contact with the tooth pulp acts in the following way: A certain degree of inflammatory hyperæmia, total or partial, depending upon the quantity of the agent applied, sets in; the blood-vessels become expanded, and here have a tendency to thrombosis. This latter effect may also be in connection with embolism of the capillaries, when the agent is quickly taken up into the blood-vessels.

"2. As_2O_3 produces no coagulation of tissue whatever.

"3. It has a specific influence upon the blood-corpuscles, combining with the hæmoglobin to form a compound of arsen-hæmoglobin, and of this chemical process there seems to be evidence in the profuse yellowish tinge of the whole pulp tissue, and in the discolouration of blood in several of the blood-vessels.

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[1] *Trans. International Med. Cong.*, London, 1881, vol. iii., p. 488.

"4. In nearly every case it is taken up *in substantia* (in form of molecules) into the blood-ways; when there it produces, besides the above-mentioned changes, granular detritus of the contents and anæmic collapse, shrinkage—the latter effect being brought about nearly exclusively in cases where greater doses were used.

"5. The bulk of the pulp-tissue—*viz.*, connective-tissue fibres and odontoblasts — undergoes no change whatever; not so the connective-tissue cells, which increase three to four times their normal size.

"6. The special action of arsenic trioxid upon the nerve-elements consists in the following: The neurilemma is only so far influenced that its nuclei are somewhat increased; a more essential change takes place in the axial part, where, after the application of more than one mgrm., granular detritus of myelin sets in, and the axis-cylinder commences here and there to disappear. As a very surprising alteration may be regarded the notchy tumefaction of the axis-cylinder, described heretofore almost only in cases of central lesions.

"7. All these alterations occur in and among normal-looking tissue.

"8. The action of arsenic trioxid is macroscopically exhibited by a brownish-red tingeing of the whole or of certain parts of the pulp-body, as well as of the neighbouring dentine and cementum, this latter in cases treated with greater doses. This alteration is most expressed at the top of the crown-pulp and at the apical one-fourth to one-third part. This circumstance may be considered as an external evidence of the devitalisation being completely attained."

Discolouration of the dentine may follow the application of arsenical dressings. It cannot always be prevented. The precautions to be taken are to relieve congestion of the pulp as far as possible, and to avoid applying the dressing until the bleeding has completely ceased.

(*b*) **Opening up the pulp canals.** This has already been referred to on page 296.

(*c*) **Removal of the pulp.**—Before attempting this step the preparation of the cavity should be finished and all *débris* removed. The pulp chamber is then disinfected, and during the subsequent operation the canals and other parts must be kept as aseptic as possible. The extracting instruments should be made of fine spring

tempered steel, of the shape shown in fig. 491. The shoulder shown in fig. 492 is a source of weakness. The instrument should be insinuated up the side of the canal until the apex is reached, then rotated four or five times before retraction is attempted. The removal of all pulp tissue from the canals is important.

Fracture of the pulp extractor may occur in the canal. If the broken portion is near the orifice it can usually be easily removed. If the fracture has occurred well up the canal an attempt may be made to entangle it with another barbed extractor, or failing this a wisp of cotton wool on a fine broach may be used. Where the broken portion cannot be removed a dressing of lin. iodi. inserted in the canal will have the effect of rusting the steel so that its removal at a subsequent visit can be easily accomplished. Instruments

(Diagrammatic.)
FIG. 491. FIG. 492.

broken in very fine canals should be allowed to remain, as they seldom cause trouble unless they pass through the apical foramen. It may happen that a small piece of nerve tissue remains alive near the apex of the canal and gives great trouble. In such a case the tissue may be removed after being destroyed by the application of strong carbolic acid, or cocaine may be used.

Great care must be taken to distinguish a small piece of nerve from a large apical foramen. If any doubt exists it is better to treat the case as one of a large foramen, as the escharotic treatment might lead to inflammatory trouble around the apex.

(*d*) **The treatment and preparation of the root canals preparatory to filling.**—Any hæmorrhage which may have followed the removal of the pulp must be arrested, and the canals dried as far as possible with cotton wool. A solution of peroxide of hydrogen should then be passed into the canals, and the surfaces of the dentine scraped with a barbed instrument with a view of removing any shreds of pulp tissue that may remain. The peroxide is then removed and a solution of perchloride of mercury, 2 per cent. in absolute alcohol, introduced. This will assist dehydration. The canals can then be dried with a blast of hot air. By these means the greater part of the canal can be dried, but the portion near the apex should be treated with a root canal drier. The canal being thoroughly dried, the root filling is introduced.

Considerable discussion has taken place during the last few years as to the **advisability of employing coagulants in the treatment of root canals.** Certain authors think that the coagulants are self-limiting in their action, and do not penetrate the dentinal canals to any great depth. They are of opinion that a coagulum is formed only at the orifice, and that the coagulum effectually prevents deeper action and complete sterilisation of the dentine. Against this statement it may be maintained that there is no proof that the contents of the tubes in the pulpless teeth are coagulable, but even if they are, the experiments of Dr. Kirk,[1] Dr. York[2] and Dr. Truman[3] furnish conclusive evidence that coagulants do penetrate the dentinal tubes. Dr. Kirk expresses a strong belief in the use of chloride of zinc, which he considers the best agent to procure an unchangeable condition of the contents of the tubules. If the apical foramen is large, a 10 per cent. solution should be employed, if fine, the strength of the solution may be 40 per cent.

The use of drills for enlarging the canals is seldom required in cases where the pulp has been devitalised or immediately removed. The canals in nearly all teeth are large enough to admit of easy filling, and with drills there is always the danger of forcing foreign matter through the apex in addition to the chances of breaking the

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[1] "On Coagulation in the Treatment of the Pulp Chamber and Canals," *Cosmos*, March, 1894, p. 181.

[2] "The Diffusibility of Coagulants in Dentine," *Dental Review*, 1897.

[3] "The Relative Penetrating Power of Coagulants," *Cosmos*, January, 1895, p. 33.

drill in the canal. Drills are useful where calcification of the pulp has occurred.

(*c*) **Filling the canals.**—For filling root canals, a large number of different materials are available, the chief being gutta percha, osteoplastics, wood, wire, celluloid, gold, tin and lead.

In filling a root the chief point is to thoroughly plug the apex.

Gutta percha is an excellent material, and is perhaps the most commonly used. It is sold ready for use by the various depôts.

The method of employing it is as follows:—With cotton-wool wound round a broach, introduce some chloro-percha up the root or root canals, using a slight piston-like action; then pass a gutta percha point up the canal as far as the apex, and by the side of it introduce one or more as may be required. The points should then be left in position for about half a minute, after which, with suitable instruments, they should be condensed and thoroughly packed into the canal. On introducing the first point a slight twinge of pain will occasionally be felt. This generally indicates that the gutta percha has passed through the apex owing to the point being too small. To meet this difficulty, remove the gutta percha and cut off the end and re-introduce. It is a little troublesome at times to hold the points of gutta percha in the forceps in the suitable position, but if the points of the forceps are slightly warmed the gutta percha adheres to them, and can be easily carried to any situation. The canals being filled, the remainder of the pulp chamber should be filled with osteoplastic cement, so that if anything goes amiss with the filling in the cavity, the osteoplastics will protect the gutta percha in the canals and prevent it becoming septic.

Canals filled with gutta percha answer admirably in all but very small canals, and it is found quite easy to get it to the apex. The only argument of any weight urged against its use is that it is liable to become septic, but if the canals are cleansed properly and filled, it is difficult to see how the sepsis is brought about.

Wood is useful in small canals and can be obtained from the depôts ready for use. The length of the canal having been obtained, a peg is selected which fits loosely in the canal. The wood is then dipped in chloro-percha three or four times, and allowed to dry. A little chloro-percha should be passed up the canal, and the peg then forced into position. A rotatory motion is then given to the wood peg, and this causes the portion in the canal to break off. An argument urged against wood is that it is liable to expand from

absorption of moisture and split the tooth. To avoid this contingency the points should be well soaked in paraffin during the process of manufacture.

Gold and copper wire and lead are used in much the same way as wood, the length of the canal being notched upon the wire, and when *in situ* the surplus is cut off.

With wire there is greater certainty of filling the apex than with any other material, but its use requires care, as it is possible to push the wire through the apex and so excite inflammation of the periodontal membrane.

Iodoform and wax in equal parts are used by many operators, but their application to back teeth is not so easy as is generally supposed. They are thus used: Loosely wrap a wisp of cotton-wool round a broach; then on a spatula or some such instrument melt a portion of iodoform and wax, pass the broach with the cotton-wool through this and insert quickly, as the material rapidly sets and is then difficult to manipulate.

Osteoplastics mixed thin and applied in the same manner as the foregoing are useful fillings, but some operators prefer to use the osteoplastic without the cotton-wool.

Gold, copper, amalgam, celluloid, plaster of Paris, paraffin, shellac, &c., have all advocates.

Mr. Badcock advocates **gum mastic and iodoform.** A wisp of cotton-wool on a watchmaker's broach is slightly dipped in a solution of gum mastic of the consistency of treacle, then into iodoform and passed into the canals. The pulp cavity is then filled with gutta percha or osteoplastic.

Where the apical foramen is large, great care must be taken to prevent the filling passing through and acting as an irritant. Gutta percha is the most suitable filling in such cases. The length of the canal must be taken, and before insertion a little iodoform or loretin should be placed at the apex. In these cases **sponge grafting** may be used. The operation consists in pushing up to and through the apex a small piece of sterilised sponge. It is important that the sponge should pass through the apex and come in contact with the soft tissues, otherwise no graft is obtained. The canal is filled in the usual way. The whole operation must be undertaken with strict antiseptic precautions.

(*f*) **The treatment of difficult canals.**—Two classes of canals come under this heading:—

(*a*) Very small canals in normal-shaped roots.

(*b*) Canals in twisted and curved roots.

Included in the first group are the canals in—

(i.) The maxillary premolars, especially the first where two canals exist instead of one.

(ii.) The buccal roots of the maxillary molars.

(iii.) The root of mandibular incisors.

(iv.) The anterior roots of the mandibular molars, especially the first.

If these canals can be cleared with a fine instrument but are not large enough to permit of treatment with drugs, the following procedure may be adopted. Absolute alcohol containing 2 per cent. of perchloride of mercury is introduced as far up the canals as possible and the canals dried with a blast of hot air. No attempt to fill the roots should be made, but little pellets containing oil of cinnamon and perchloride of mercury should be placed over the orifices.

A method of dealing with difficult and inaccessible root canals has been introduced by Dr. Weld.[1] It is known as **the chemico-metallic method.** The canals are not cleared of the devitalised pulp, but into each canal a bristle of metal composed of silver, tin, and zinc is passed, the metal being first dipped in a solution of slightly modified nitro-hydrochloric acid. The products formed by the combination of the acid and metal with the pulp material is said to form an albuminate. The results following this form of treatment are said to be satisfactory. **Where the canals are inaccessible to the finest instruments** they may be left alone and a little mummifying paste (see page 399) placed over the orifices before inserting the cavity filling.

For the treatment of small canals Dr. Callahan (*Cosmos*, 1895) recommends **the use of sulphuric acid**, 50 per cent., and his method has been warmly advocated by many, including Dr. Bönnecken. A drop of the sulphuric acid is conveyed to the orifices of the canals and gradually worked in by the aid of fine Donaldson bristles. The acid dissolves the lime salts, forming calcium sulphate, and so enlarges the canal. Sodium peroxide is next introduced into the canal, a bristle very slightly moistened is passed into the powder and then into the root. The sodium

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[1] *Cosmos*, p. 20, 1897.

peroxide in the case of putrescent canals forms soap, and destroys the fatty contents of the canal, and the rapid evolution of H_2O_2 ejects the contents into the pulp chamber.

$$H_2SO_4 + Na_2O_2 = Na_2SO_4 + H_2O_2.$$

The latter is in a nascent condition, and effects prompt sterilisation. The procedure of alternately using the sulphuric acid and sodium peroxide is repeated until the canal is quite clear. By this method it is possible to cleanse and fill canals which by the ordinary treatment are inaccessible. Pumping the acid through the apex must be avoided.

If canals cannot be found, a pledget of cotton wool cemented in the cavity for twenty hours will often define the entrance to the canals. They stand out as dark spots on a white background.

In twisted and tortuous canals the pulp is to be removed as far as possible, and one of the methods suggested for mummifying the pulp should be adopted.

(3) MUMMIFICATION OF THE PULP.

This operation consists in first applying a devitalising agent to the pulp, and, at a subsequent visit, removing the coronal portion and applying medicaments to the portions remaining in the root or roots and filling the cavity permanently. It is important that all the stages of the operation should be carried out under strict antiseptic precautions.

The following preparation suggested by Söderberg[1] gives good results :—

Aluminis exsiccati }
Thymol } .. .. āā ʒi.
Glycerini }
Zinc oxid. q. s. to make a stiff paste.

In this paste the thymol acts as the antiseptic, the alum as the mummifying agent, the zinc oxide as the colouring medium and the glycerol as the binding and penetrating agent.

Miller, of Berlin, suggests a mixture of perchloride of mercury ·0075 grams., thymol ·0075 grams., made in the form of little pellets. The perchloride of mercury at times causes pain, and also has the disadvantage of staining the tooth structure, but in the case of

[1] *Cosmos*, November, 1895, p. 922.

posterior teeth the staining is immaterial. With this combination the living portions of the pulp are rapidly killed by coagulation of the cell protoplasm and then impregnated with the sublimate and thymol and so sterilised. Dr. H. Bönnecken[1] has devoted attention to this question, and gives an account of two cases in which he was able to make a microscopical examination. He found the pulps in a state of fatty degeneration, globules of colloid and calcareous matter being present in the bundles of connective tissue, and the capillaries thrombosed. He suggests the following, and carries out

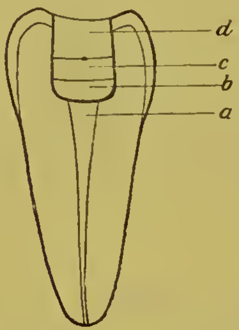

FIG. 493.—(*a*) Devitalised pulp; (*b*) mummifying paste; (*c*) osteo-plastic cement; (*d*) metal filling.

the treatment forty-eight hours after the application of the arsenical dressing:—

℞	Cocainæ, Thymol	āā ʒi.
	Misce exactissime terendo et adde—	
	Formaldehydi Soluti (40 per cent.)	♏ xl.
	Zinci oxidi	ʒii.
	Misce. Fiat Pasta.	

When cocaine and thymol are rubbed together in the mortar they deliquesce, taking up moisture from the air. Therefore, after the addition of ten drops of formalin a relatively large amount of oxide of zinc must be added to give the mixture the consistence of a paste.

Dr. Bönnecken finds that the preparation does not give rise to pain and that there is no discolouration. With a stronger percentage of formalin pain is liable to occur.

[1] *Oesterreichisch-ungarische Vierteljahrsschrift für Zahnheilkunde*, vol. xi.

Pulp mummification is useful in (*a*) fine canals from which the pulp cannot be removed; (*b*) nervous and weak patients unable to undergo tedious root filling; (*c*) canals which are twisted and tortuous.

At this stage the comparative value of the three methods of treating the exposed living pulp may be reviewed. "Capping," if successful, possesses the advantage of retaining the pulp alive and avoiding the tedious operations following devitalisation, but on the other hand it is peculiarly uncertain in its results when used for the treatment of septic pulps. If a septic tooth be capped it may be quite free from trouble at first, but sooner or later, in the large majority of cases, the pulp dies and periodontal trouble appears. "Capping" gives good results in small traumatic exposures, but, in all cases where the pulp is affected by inflammation, devitalisation gives more reliable results. "Mummification" has hardly had sufficient trial to warrant the expression of any definite opinion as to its value, but it does not seem to yield such reliable results as complete extirpation. It is, however, useful in the places and under the conditions referred to above.

(4) IMMEDIATE REMOVAL OF THE PULP.

Immediate removal of the pulp may be carried out under an anæsthetic. In cases of fracture of the anterior teeth, with the pulp easily accessible, nitrous oxide may be employed, but with the premolars and molars and exposures in the anterior teeth due to caries, the operation should be carried out under cocaine or some suitable local anæsthetic. The rubber dam is first applied and the cavity thoroughly disinfected. A pledget of cotton wool dipped in cocaine (20 per cent. in saturated solution of boracic acid) is applied to the exposed surface and allowed to remain until the surface is anæsthetised. The pulp chamber can then be opened up and access gained to the canals. A fresh application of cocaine is then made and the pulp removed.

(C) WHEN THE PULP IS DEAD.

If the contents of the pulp cavity in which the nerve is dead be examined, they will be found to vary according to the pathological conditions that have caused the death of the pulp.

(i.) The gangrenous pulp may be entire, or may have undergone disintegration, leaving the contents moist and in a sloughing condition which, in most instances, terminates in complete disorganisation.

(ii.) The contents may be dry and granular.

(iii.) The pulp tissue may be transformed into a cheesy mass. This condition, which is probably due to a form of fatty degeneration, is found in those pulps which have been "capped," or have died under fillings.

Teeth with dead pulps may be divided into—

(1) Those uncomplicated by periodontitis.

(2) Those complicated with periodontitis, sub-divided into—

(*a*) Acute periodontitis.

(*b*) Productive periodontitis.

(*c*) Chronic suppurative periodontitis.

The treatment of pulpless teeth is a matter of great practical importance, and opinions are divided as to which is the best method to adopt. There are two methods advocated: in the one the canals are cleansed, rendered aseptic, and filled at one sitting; in the other the canals are dressed frequently before filling.

The first method, or **immediate root filling**, is carried out as follows:—The cavity must be cleared of all carious material and the pulp chamber opened up freely, frequent syringing with warm water being useful to remove the *débris*. Access to the canals should be gained and the preparation of the cavity completed. The rubber dam, or some other method for excluding saliva, should be used, and the cavity, having been dried with cotton wool, should be swabbed out with peroxide of hydrogen. With hooked nerve extractors the canal should be carefully freed of *débris*, and in carrying out this part of the operation a word of caution is necessary. There is a danger of septic material being forced through the apical foramen, and to obviate this the cleansing process should gradually proceed from the orifice of the canal to the apex, peroxide of hydrogen being frequently introduced into the canal to sterilise the pulp tissue and prevent septic inflammation, should any of the pulp tissue pass through the apex. The canals should then be treated with some antiseptic solution introduced on a wisp of cotton wool, a rotatory rather than a pumping action being employed.

The pulp tissue having been removed as far as possible, the advisability of enlarging the canals with reamers must be considered.

The canals should be enlarged in all cases where a septic condition exists. The dentine bordering the canal is infected, and is therefore removed in the process of enlarging. The canals should then be thoroughly disinfected and treated as suggested on page 396 and the canals filled. **The success of immediate root filling depends upon the thoroughness with which the various steps of the operation are carried out.**

Those who do not pursue the immediate method adopt practically the same mode of procedure, but instead of filling the root at one sitting they insert dressings, changing them until the canal is considered to be aseptic.

Dr. Schreier has recommended a mixture of **sodium and potassium for dealing with septic roots.** The mixture consists of two parts of sodium to one of potassium, and is used as follows:—The cavity is prepared and the pulp chamber opened up so as to allow free access to the root or roots. The rubber dam should be always applied. With a warm instrument an opening is made through the wax covering the mixture. A fine broach—iridio-platinum for preference—is introduced into the preparation and withdrawn; the broach with the adherent mixture is then introduced into the canal. This step is followed by a slight hissing or explosion. One application is usually sufficient for each root, but this depends upon the amount of septic matter in the canal and the quantity of kalium-natrium introduced. "Potassium and sodium hydroxides are formed which, in combination with the fat of the pulp, form soap. A portion of the alkalies render the albuminous substances in the canal soluble, and in this way tissue adherent to the walls is dissolved and access easily obtained to the dentinal tubes." The kalium-natrium is said to possess germicidal properties, partly by the heat set up and partly by the new product formed. The introduction of the kalium-natrium should be followed by the use of sodium or hydrogen peroxide. In practice the method yields good results, and its use is indicated in canals the contents of which are very putrid.

(1) CASES UNCOMPLICATED BY PERIODONTITIS.

In these cases immediate root filling should be adopted.

(2) CASES COMPLICATED WITH PERIODONTITIS.

(*a*) **Acute.**—Under these conditions it is important if possible to remove the contents of the canals, but this can seldom be thoroughly carried out. An entrance, however, should be made into the pulp chamber. If the tooth is free from caries, or a filled cavity is present, an opening should be made in the canal by drilling a small hole just under the gum margin, and treatment for acute periodontitis prescribed. If a cavity exists, the pulp cavity should be opened and the contents removed and a loose antiseptic dressing placed in the cavity and free syringing with antiseptics carried out. If possible the contents of the canal should also be removed, but this is seldom practised. The pulp chamber should be syringed daily, and, when the inflammation has subsided, the canals sterilised and filled. In opening up teeth with acute periodontitis much pain may be saved by keeping the tooth steady.

(*b*) **Cases complicated with productive periodontitis.**—In these cases the canals can be cleansed, disinfected and filled at the one operation, but the operation must be thoroughly performed.

(*c*) **Cases complicated with suppurative periodontitis.—If suppuration exists but the pus is confined,** the canal must be freed of all septic matter. The abscess cavity should then be opened by trephining through the alveolar process (see page 415) and the suppurating surface scraped. If the canal is free from pus, it should be thoroughly disinfected and filled at once. The abscess cavity is then packed with iodoform gauze and made to heal by granulation. If at the first visit the canal cannot be freed from moisture at the apex, it should be dressed with a solution of chloride of zinc and the abscess cavity packed as just recommended. At the next visit it will usually be found that the canal can be thoroughly dried and filled.

If a sinus is present on the gum a similar line of treatment is to be adopted.

(D) THE EMPLOYMENT OF DRILLS IN CANAL TREATMENT.

Before using root drills it is well to pass up the canal a fine unbarbed instrument on the shank of which is a small piece of rubber —this will indicate roughly the direction of the canal and its length, the length being marked by the position of the piece of rubber. The drills should be used on the engine. Care should be taken to see

that they are spring tempered, and that, when in use, they are in a direct line with the root to be filled. They should be employed with a "touch and go" movement, and persuasion, not force, used, the pointed head of the drill guiding the instrument along. Frequent withdrawals should be made to allow the removal of *débris*, and the depth to which the drill has gone should be tested by the "Donaldson." It is important to start with a small drill at first, substituting larger ones from time to time. The first drill should reach the apex; the larger ones should, however, not reach quite so far. The subsequent treatment of the canals is essentially the same in all respects as that previously described. The use of drills is sometimes attended by accidents.

The causes leading to fracture of drills are:—

(1) The use of rusty drills (this is best avoided by keeping the drills in oil).

(2) Pushing the drill up too rapidly, and thus causing it to become fixed.

(3) Through not having a sufficiently large opening into the cavity, and so trying to work the drill round the corner.

Perforation of the apex with a drill is caused by using a small drill with too much force.

Perforation of the side wall of the canal may occur. This is often due to the employment of large drills in small canals, for example, in the upper lateral incisors, buccal roots of upper molars, &c. It may arise from attempting to drill round the corner, especially when injudicious force is employed to make the drills advance.

Treatment.—Should the drill break in the canal, efforts should be made to remove it. The canal should be first enlarged and an attempt made to get hold of the broken drill with a pair of forceps—those specially designed by Mr. George Seymour are useful for this purpose. If the attempt fail, a strong barbed instrument should be passed up the canal and an endeavour made to hook down the broken drill. Cotton wool at the end of a broach to entangle the drill may be tried. If the drill cannot be removed by these methods it must be left in the canal or rusted out by applications of iodine.

With regard to **perforation of the apex**, the best treatment is to syringe the canal with a solution of peroxide of hydrogen, arrest the hæmorrhage, and then disinfect and fill the canal.

Perforation of the side of the canal often ends in loss of the tooth, but with care the tooth may be retained for some time. The general treatment of the canal should be carried out in the usual way. The injured periodontal membrane is then to be covered with a layer of iodoform or loretin and the perforation covered with a small piece of platinum and the canal filled. This treatment can only be carried out when the perforation is near the neck of the tooth; when near the apex iodoform should be placed in the upper part of the canal and a gutta percha filling inserted.

(E) BLEACHING TEETH.

Pulpless teeth often become discoloured. In some cases the discolouration is hardly perceptible, while in others it is marked, being often of a bluish black. Teeth in which the pulp has died from the effect of injuries seem to discolour most, and the teeth of the young are more liable to be affected than those of adults. The discolouration is said by some writers to be due to the passage of the colouring matter of the blood into the dentinal tubes, but until the nature of the product formed in the dentinal tubes is definitely known it is difficult to decide if this view is correct. Staining of the tooth structure may also be due to the use of amalgam as a filling, and this is referred to under amalgam.

To remedy the unsightly appearance of discoloured teeth the process of bleaching is recommended. The results obtained are not, as a rule, satisfactory, but this is said by Dr. Truman ("American System of Dental Surgery," vol. ii., p. 297) to be due to defective manipulation. Amongst the agents suggested, **chlorinated lime** seems to be the most serviceable, and its use is advocated by Dr. Truman, who adopts the following method:—Cleanse the canals and cavity of all softened and decayed dentine, and fill the upper third of the canal with some form of root-filling. The remaining portion of the canal and the cavity should then be washed with a solution of bicarbonate of soda, borax or ammonia, as these will remove all fatty material. Another washing with distilled water is then given, and the rubber dam applied, the cavity being thoroughly dried. The chlorinated lime is then rapidly packed into the cavities by dipping the instrument in a 50 per cent. solution of acetic acid and taking up the lime upon the moistened instrument, the cavity being sealed with gutta percha

or osteoplastic. At the end of two or three days the dressing of lime is renewed, the dressing being repeated until the tooth is bleached. It is most important to use distilled water at all times for syringing, and to avoid the use of steel or iron instruments. The acetic acid is used to set free the chlorine from the chlorinated lime. The bleaching of the tooth will be first observed near the cutting margin, that portion of the tooth towards the neck occupying a longer period. When the tooth is brought into a satisfactory condition the remaining part of the canal must be filled with oxy-chloride, and the walls of the cavity also lined with this material before the filling is inserted. The reason for using the oxy-chloride is that the tubuli are filled with decomposable material, and the oxy-chloride, being a more powerful antiseptic than the oxy-phosphate, is better.

Dr. Kirk suggests a method based upon the activity of **sulphurous acid** (SO_2) as a bleacher. Sodium sulphite (100 grains) and boracic acid (70 grains) are desiccated separately, and then intimately ground together in a warm dry mortar, after which they are stored until required in a securely stoppered bottle. The powder is packed into the cavity and a drop of water is added to the powder immediately before the cavity is sealed. The sulphurous acid is set free as a result of the chemical reaction—

$$Na_2SO_3 + 2HBO_2 = 2NaBO_2 + H_2O + SO_2.$$

Dr. Harlan recommends the use of **aluminium chloride.** The rubber dam is applied and the cavity swabbed out with peroxide of hydrogen and then dried. Chloride of aluminium is moistened with peroxide of hydrogen and allowed to remain in the cavity for five minutes, after which the cavity is syringed with a solution of bicarbonate of soda and dried. This method gives fair results. The chemical reaction is as follows: —

$$Al_2Cl_6 + 3H_2O = Al_2O_3 + 3H_2O + 3Cl_2.$$

Pyrozone (at 25° ethereal solution of hydrogen peroxide) gives good results. The tooth must be isolated with rubber dam. The pyrozone is placed in the cavity on a pledget of wool and decomposed with an air blast from the hot air syringe. The treatment needs to be continued for about a quarter of an hour, when a small amount of pyrozone may be left in the cavity and the filling of gutta percha or oxy-phosphate inserted. It is well to seal the apical foramen before applying the drug.

Pyrozone must be used with great caution in living teeth. In teeth discoloured by metallic stains, little improvement can be anticipated from bleaching. In the majority of cases it is better to remove the discoloured dentine as far as is safe, and then to fill or line the cavity with some light-coloured osteoplastic.

CHAPTER XII.

Diseases of the Periodontal Membrane.

(A) INFLAMMATION.

Inflammation of the periodontal membrane is termed periodontitis.[1] The pathological changes which take place are similar to those observed in other tissues, namely, dilatation of the vessels allowing an increased flow of blood to the part, retardation ensuing followed by stasis. Leucocytes escape through the vessel walls to the surrounding tissue, and the amount of serum exuding from the vessels is considerably increased in quantity. If the injury causing the inflammation has been slight and does not persist, and there has been no infection, the process may undergo resolution as in other parts of the body. If, however, the irritant is persistent or the inflammation is of a septic character, suppuration will take place. Under these conditions the pus may escape at the gingival margins of the gums, or it may be confined and so cause a dento-alveolar abscess. If the injury or the irritation is slight, but continued, one of two things happens: (i.) the products of inflammation may by their pressure produce absorption of the cementum and dentine—a condition similar to rarefying osteitis; this type of periodontitis may, therefore, be called "rarefying periodontitis"; (ii.) the products of inflammation may become organised into cemental tissue, a condition analogous to osteo-plastic periodontitis; this type of periodontitis may therefore be styled "productive" or "proliferative" periodontitis.

Periodontitis may be divided into local and general.

(1) LOCAL PERIODONTITIS.

By local periodontitis is understood an inflammation limited to one tooth and of local origin. The inflammation may be acute or chronic, and may start near the apical portion of the tooth, on the lateral aspects, or at the gingival margin. It may be simple or septic.

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[1] The term pericementitis is usually adopted in America.

(*a*) Acute.

(i.) *Commencing near the apex of the tooth.*

(*a*) **Causes.**—The principal causes of this form is septic infection from the pulp chamber through the apex of the tooth. It is quite possible that in some instances infection may be due to pyogenic organisms circulating in the blood, the periodontal membrane being a "locus minoris restantiæ." In a few cases (see page 413) the infection would seem to have been conveyed by a pulp which is in the early stage of suppuration.

Morbid anatomy and pathology.—The effect of the primary hyperæmia and dilatation of the blood vessels is to cause uprising of the tooth from its socket. Owing to the intimate relationship of the blood of the periodontal membrane and the gum the latter tissue becomes involved at an early stage. The presence of inflammatory products in the periodontal membrane leads to the tooth being pushed still further from its socket. The inflammatory process may not reach beyond this stage. When once suppuration has taken place **the pus burrows in the direction of least resistance.** It may escape at the gingival margin, but in the majority of cases it burrows through the outer alveolar wall and points on the gum over the affected tooth. As long as the pus is confined in the bone the muco-periosteum is only slightly œdematous, the cellular tissue of the face being unaffected. But when the pus has gained an exit through the alveolus a rapid swelling of the cellular tissues takes place owing to a diffuse cellulitis. The extent of the swelling is determined by the virulence of the organisms producing the suppuration and by the resistance of the tissues. The abscess may discharge spontaneously, and if the tooth or source of infection be removed healing by granulation usually ensues. In the event of the source of infection remaining, the surface is kept constantly infected and a chronic sinus results. The pus at times burrows in different directions to those mentioned above. It may pass to the gingival margin through the outer alveolar plate. In suppuration around the superior central and occasionally the lateral incisors, the pus may make its way into the nasal fossa. Pus from the region of the superior lateral incisors is prone to burrow under the muco-periosteum of the hard palate, and form a large fluctuating swelling which usually points at the junction of the hard with the soft palate. Although this condition occurs most frequently in

connection with the lateral incisor it may arise from the second premolar, the first molar, or indeed any tooth in the maxilla. The pus may take a direction towards the antrum, invade this cavity and lead to antral suppuration. This occurs generally in relation with the second premolar or the molars, but may arise from any tooth in the maxilla. Pus around the canine may burrow upwards towards the inner canthus of the eye. In a patient attending the Dental Hospital of London, an abscess in connection with the maxillary first premolar pointed at the angle of the mouth.

In the mandible the pus, instead of working its way through the outer alveolar plate, may penetrate the inner side of the alveolus and open on the floor of the mouth. From the incisors and canines the pus, especially if penetrating the outer alveolar plate low down, may strip up the periosteum and eventually open under the chin. The insertion of the buccinator influences, in many cases, the direction taken by the pus. If the pus penetrates the bone outside the attachment of the buccinator it will burrow into the tissues of the cheek, and finally perforating the skin open on the face. In rarer examples the pus may continue to work among the planes of connective tissue at the neck, producing a diffuse cellulitis (*angina Ludovici*). Several cases of this type have been recorded. The onset of the cellulitis is attended by a marked increase of the temperature, rigors often occur, and there is great prostration. There is marked œdema of the tissues forming the floor of the mouth, the mucous membrane being pushed up so as to frequently suggest a second tongue. The swelling increases rapidly over the front of the neck, spreads backwards to the parotid region, upwards to the orbit, and in the later stages involves the thorax. There is usually œdema of the larynx. The brain may become involved by extension of phlebitis along communicating venous branches. The condition nearly always terminates fatally. A case of extreme severity which, however, terminated favourably, was recorded by Mr. A. Kendrick.[1] The trouble arose in connection with a first left mandibular molar which one year previously had been fractured. The left eye was closed, and pus escaped from the lower orbital margin and from the upper eyelid, a large sloughy opening being present in the centre of the cheek. There were several sinuses along the border of the man-

[1] *Journal of the British Dental Association*, October, 1900.

dible. The pus had travelled down the anterior border of the sterno-mastoid to the clavicle, where severa sinuses opened; there was also a large sinus over the sternum. Pus had burrowed upwards along the ascending ramus into the temporal fossa, so that the whole temporal region was œdematous. The tooth was removed. The temporal region was incised and the sinuses freely opened up and packed with iodoform gauze, the patient making a steady recovery. The most severe form of dento-alveolar abscess would seem to arise in relation with the mandibular molars. The pus at times burrows under the masseter, and in other cases under the internal pterygoid, and finally into the deeper cellular tissue. Dr. R. Maclaren[1] has drawn attention to this variety of abscess, and records the *post mortem* of a case in relation with a second molar: "the neck of the root was found tightly embraced by the gum, which had prevented the escape of matter. As a consequence the pus had welled over the inner alveolar plate and had separated the periosteum and burrowed along the internal pterygoid and among the muscles and cellular tissue on the inside of the mandible." Dr. Maclaren states that he has constantly observed a similar condition. Whether the pus wells over the inner or outer edge of the alveolar border he considers to depend upon the respective level of the two edges, and from an examination of 227 mandibles in the Museum of the Royal College of Surgeons of England he finds that in 86 the inner alveolus was on a lower level than the outer, and in 78 the reverse was the case. In 63 both inner and outer appeared equal in height.

Extensive necrosis of the maxilla or mandible may result from dento-alveolar abscess (see chapter xxiii.). In severe cases sapræmia, septicæmia or pyæmia may occur.[2]

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[1] *The British Medical Journal*, October 20, 1894, p. 866.

[2] The following cases recorded may be useful for reference:—

A Case of Alveolar Abscess. Death from Pyæmia. F. Willcocks, *Lancet*, 1898.

Pyæmia due to Alveolar Abscess. J. Edmundson, *Lancet*, August 27, 1898.

A Case of Septicæmia the Result of Alveolar Abscess. L. Hounsell, *Dental Record*, September, 1896.

Chronic Pyæmia following Alveolar Abscess. Howse, *Medical Times and Gazette*, 1876.

A Case of Death from Alveolar Abscess, resulting in Thrombosis of the Cavernous Sinus. Pearce Gould, *Journal of the British Dental Association*, March, 1886.

The pus from cases of dento-alveolar abscess contains pyogenic and other organisms. Schreier's investigations go to show that the organisms that are found in the deeper parts of the suppurating pulp are those usually present in the pus from cases of acute suppurating apical periodontitis.

Within the last few years several cases of acute suppurative perio ontitis in connection with teeth with living pulps have been recorded. Two very interesting cases of this character have been reported by Mr. A. E. Baker.[1] In one, a girl aged 13, there was a small cavity on the lingual surface of the right maxillary lateral incisor. The nerve was exposed and a dressing of devitalising material was applied for half an hour, when the cavity was enlarged and a fresh dressing applied. Five days subsequently the patient returned with a large dento-alveolar abscess pointing in the sulcus between the gum and upper lip. The abscess was opened. The next day the dressing in the cavity was removed and the cavity left open to allow the abscess to drain, the assumption being that the nerve was dead. When seen five days later the abscess was apparently cured, but the pulp was found to be partially alive. It was removed and the canal filled.

The second case was in connection with a left maxillary second premolar distal cavity. Remnants of pulp remained at the apices; to these arsenic was applied. A mesial cavity in the first molar was prepared, and a layer of softened dentine left over the pulp. A dressing of Sandarach varnish was packed into the cavities to press away the gum. After two days the patient returned with a large abscess. The pulp of the molar was found acutely sensitive and arsenic was applied. The root canals of both teeth were subsequently cleared and filled. In both these cases Mr. Baker considered it probable that the periodontal membrane had been infected *viâ* the living pulp.

Signs and symptoms.—In the early stages the tooth feels somewhat uneasy, is slightly raised in its socket, and pressure brings relief. At this period the vessels are in a condition of hyperæmia. The tooth then becomes still further elongated and loose, the gum around being swollen and painful. Pressure now causes great pain. The vessels at this period are nearing the con-

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[1] *Journal of the British Dental Association*, May, 1895, p. 286.

dition of stasis, and the surrounding tissues are infiltrated with inflammatory exudation, hence the increased rising of the tooth in its socket. Pressure now increases the pain, because the vessels can no longer be freed of their surplus supply of blood. Each act of mastication under such conditions only increases the pressure on the already hyper-sensitive nerves. If suppuration supervenes the swelling of the gum increases, the tooth becomes more loose and the pain dull and throbbing. Finally a distinct fluctuating swelling appears in the sulcus between the gum and the cheek, the face swells quickly, and the pus being no longer confined in a dense unyielding structure, the tension upon the nerve endings is relieved and the pain considerably lessened. Suppuration is usually accompanied by pyrexia.

Diagnosis.—The diagnosis is usually easy. In cases where suppuration has taken place the surrounding teeth may have become implicated in the inflammation, but the tooth causing the trouble will be found looser than its neighbours and more sensitive to pressure and percussion.

Treatment. *Local.*—The first point to decide is the advisability of retaining the tooth. Teeth that are not capable of being saved by filling or crowning should be removed. In nearly all other cases an attempt should be made to save the tooth. If possible the septic matter in the pulp chamber should be removed. Care should be taken in performing this operation, as such teeth are extremely sensitive and the tooth should be kept as firmly fixed as possible.

Although complete removal of the septic matter can be hoped for in only a few cases, an effort should always be made to gain an entrance to the pulp chamber, and for this purpose a small hole should be drilled through the tooth at the neck. This can be accomplished with a sharp bur without causing much pain. The pulp chamber should be syringed with an antiseptic solution (hydrogen peroxide, 20 vols., is recommended). Counter-irritation of hot fomentations[1] should be applied to the gum over the root, or the gums may be scarified. **If suppuration has occurred** measures must be taken to remove pus as soon as possible. This may be hastened by the continued application of poultices over the situation of the tooth, and, as soon as the pus has pointed, the abscess should

[1] A raisin cut in two and toasted makes a useful poultice. The cut side should be applied to the gum. Another efficacious method is as follows:—

be opened. The cavity should be thoroughly irrigated with some unirritating antiseptic solution and means provided for drainage. The abscess should be dressed at least twice a day, and this is especially needful when it occurs in the mandible, as the opening is not then in the most dependent part. Acute dento-alveolar abscesses generally heal rapidly, especially if carefully dressed. In the case of extensive abscess the patient must be anæsthetised, the suppurating tracts freely opened, irrigated and packed with iodoform gauze; but this is a subject belonging rather to the domain of general surgery.

If the skin shows signs of being involved in the inflammatory process it should be dressed with a compress dipped in some mild astringent solution (lotio plumbi). If the abscess threatens to open through the skin the latter should be supported by covering the surface with a layer of cotton wool painted over with collodion solution ; by this means, aided by free opening of the abscess into the mouth, the opening on the surface can often be avoided. When an opening through the skin is unavoidable an incision should be made at the earliest opportunity, and the abscess on no account allowed to burst spontaneously. If this precaution is taken much disfiguration may be avoided. The incision should follow, as far as possible, the fibres of the platysma. A cut across the fibres leaves a gaping wound, whereas when the cut is parallel with them the resulting scar is almost imperceptible.

When the patient will consent, a much better course is to open the apical space through the alveolus, an anæsthetic being administered. An incision is made in the gum down to the bone. The hæmorrhage is arrested, the periosteum covering the part to be penetrated is scraped away, and the apical space opened with a trephine on the dental engine. The cavity is then syringed and the opening packed with iodoform gauze.

In opening an abscess connected with a mandibular molar, care must be taken to avoid injuring the facial artery. In cutting, the knife should be directed towards the bone and not away from it. In opening abscesses in the palate the anterior or posterior palatine

Take a child's cotton glove, cut off the fingers and fill them with bread ; sew up the open ends and attach to each a piece of thread ; place the poultices in boiling water, leaving the threads out. By this means a continuous application of heat may be obtained.

arteries may be injured. The incisions into palatal abscesses should therefore be made as far as possible parallel with the course of these vessels.

As soon as the active stage of inflammation has subsided the pulp canals should be treated in the usual way. **In those cases where suppuration is extensive** and the pus shows signs of burrowing in an unusual direction, the tooth should be immediately removed.

General.—In the early stages a smart saline purge will assist in clearing up a local periodontitis, especially if simple in character. If suppuration has taken place, the necessity of attending to the general health of the patient cannot be too strongly insisted on. The bowels should be carefully regulated, and, if needful, a tonic treatment prescribed consisting not only of drugs but plenty of fresh air and good wholesome nourishing diet.

(β) *Simple.*—**Causes. A simple acute local periodontitis starting near the apex** may arise from the passage of medicaments through the apex or from injury to the soft tissue by the passage of instruments in the process of preparing the canals. Passage through the apex of the material used for filling the canals may be cited as a cause. The inflammation may be simple, but if the irritant is allowed to remain suppuration may follow.

Treatment consists in the application of counter-irritants or hot fomentations to the gum. The inflammation usually subsides in the course of a few days. When due to excess of root filling, the filling must be removed. The presence of excess material can be diagnosed by the aid of the X-rays.

(ii.) *Commencing on the lateral surface of the root.*—In a few cases of local periodontitis the inflammation commences on the lateral surface of the root. It is usually simple in character. The chief **causes** are traumatism such as a blow, the too rapid separation of teeth for filling, or the application of too much force when regulating teeth by mechanical appliances. Perforation of the roots during the treatment of pulp canals may be cited as another cause. In the latter case the inflammation may be septic in character. **The symptoms and treatment** are similar to those described under apical periodontitis. The inflammation may occasionally be gouty. One patient under observation has periodical attacks of acute local periodontitis for which no cause connected with the tooth can be found. This patient is distinctly gouty, and suitable general treat-

ment for these attacks has been tried without avail, relief only being obtained on removal of the teeth. The surfaces of the teeth generally have particles of acutely inflamed membrane adherent to them. In this patient the application of an arsenical dressing to the pulp promptly starts an attack of acute periodontitis.

(iii.) *Commencing at the gingival margin.*—This form of periodontitis starts as a gingivitis. The **causes** are injury from careless application of clamps, or clasps or dentures pressing on the tissue, irritation from elastic bands used for regulation purposes, and the action of escharotics, such as arsenious acid. The inflammation may be simple or suppurative. The periodontitis in connection with partially erupted mandibular third molars frequently starts at the gingival margin. A gingivitis is started partly by food and *débris* becoming impacted under the partial covering of gum, or by irritation from the opposing tooth. The inflammation spreads to the periodontal membrane, and suppuration frequently ensues (see impacted third molars, p. 18).

Symptoms.—The gum around the affected tooth is swollen and congested. The tooth is tender to touch and looser than normal. Pus will be found welling up around the neck of the tooth if suppuration has occurred.

Treatment.—The cause should be removed and the socket syringed with an antiseptic solution (hydrogen peroxide), counter-irritants being applied to the gums. In advanced cases, for instance where elastic bands have been allowed to work up the root, it may be necessary to splint the tooth to its neighbours in order to obtain "rest." In cases due to escape of drugs, such as arsenious acid, the slough should be scraped away and the pocket around the tooth syringed with antiseptics. In those rare cases where the periodontal membrane is sloughing from infection, all sloughs must be removed and the surface thus bared treated with some escharotic, such as nitrate of silver or carbolic acid.

(*b*) Chronic.

(i.) *Commencing near the apex or on the lateral aspects of the root.* — In chronic inflammation the periodontal membrane becomes swollen and thickened from a small-celled infiltration. The inflammatory material under appropriate treatment may be absorbed (rare); more frequently one of three changes occurs: (1) the

inflammatory products may increase, and by their pressure produce absorption of the cementum and dentine on the one hand and of the bone on the other (**rarefying periodontitis**); (2) the products of inflammation may be replaced by calcified tissue, cemental in character (**productive periodontitis**); or (3) suppuration may take place (**suppurative periodontitis**).

For convenience of description chronic local periodontitis will be considered under the above headings. The student should remember that they are all one and the same disease in different stages, frequently blending with one another or replacing each other. The variety depends to a great extent on the intensity of the inflammation and the vitality of the tissues affected.

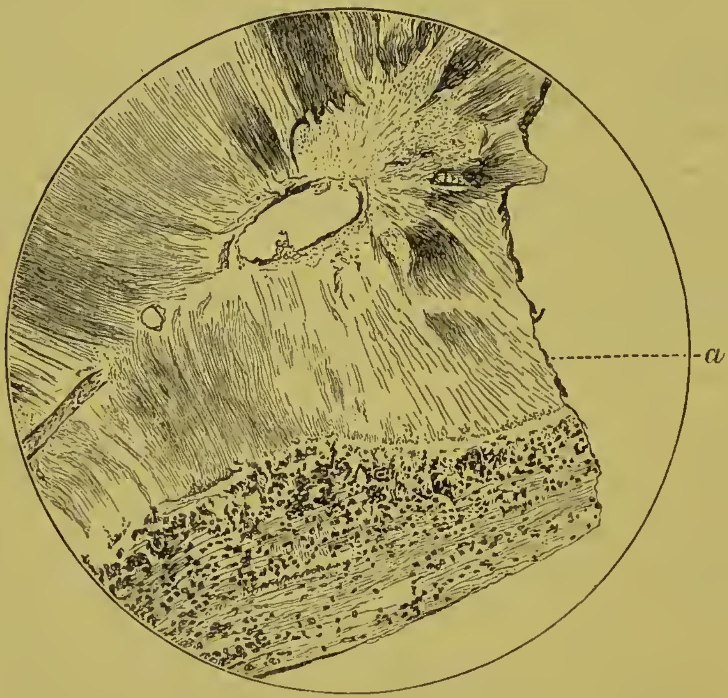


FIG. 494.—(*a*) Margin of tooth, showing Howship's lacunæ. From a specimen in the possession of Mr. Douglas Caush.

Causes.—The causes may be divided into (1) septic, (2) non-septic. Among **septic** are infection from the pulp chamber or perforation of the root by a septic instrument. The **non-septic** causes are traumatism, such as perforation of the root, passage of

root fillings through the apical foramen, and too rapid separation of teeth preparatory to filling. The regulation of teeth by mechanical means often results in chronic periodontitis. Replanted and transplanted teeth are frequently the seats of chronic inflammation. A frequent and overlooked cause is mal-occlus on or excessive use. Chronic periodontitis may be a sequel to acute periodontitis.

(*a*) **Rarefying periodontitis.**—This form of periodontitis varies considerably in its intensity. A section through the tooth and periodontal membrane will show the ordinary small-celled infiltration usually seen in chronic inflammations. On the surface of the dental tissue, in contact with the inflamed part, a series of semi-

FIG. 495.—Mandibular first molar, showing loss of tissue, the result of rarefying periodontitis.

FIG. 496.—Maxillary first molar, showing the effect of rarefying periodontitis.

lunar excavations will be noticed (Howship's lacunæ) (fig. 494). In each space a giant cell is present, and in the neighbourhood are to be seen epitheloid cells and small cells, the appearances being in all respects similar to those seen in absorption of the deciduous teeth under normal conditions. As the absorption progresses the cementum is first removed and then the dentine, and in rare cases the entire root may disappear. The inflammation may be slight in intensity but continuous, and under such conditions the absorption takes place evenly, the root to the naked eye presenting a smooth round surface when the inflammation is near the apex. (See figs. 495 and 496.)

If the inflammation is very active the absorption takes place irregularly (see figs. 497 to 502).

Under certain conditions, *e.g.*, the lessening in the intensity of the inflammation, the rarefying periodontitis may pass into the stage of a productive or proliferative periodontitis and much of the lost tissue may be replaced to be perhaps again removed if the inflam-

FIG. 497.

FIG. 498.

FIG. 499.—A maxillary central incisor which had been crowned.

FIG. 500.

FIG. 501

FIG. 502.

FIG. 503.—From a specimen in the possession of Mr. Douglas Caush.

mation becomes still more active. In other cases the inflammation may cease altogether and the small-celled infiltration be replaced by cementum. In the case shown in fig. 503 the dentine has been absorbed and replaced by cementum. This specimen therefore indicates the existence of a rarefying periodontitis followed by the replacement of the small-celled infiltration by cementum, a condition analogous to healing in soft tissue by granulation. In these cases the granulation tissue instead of organising may break down and a suppurative condition result. A rarefying periodontitis therefore becomes either a productive or a suppurative periodontitis.

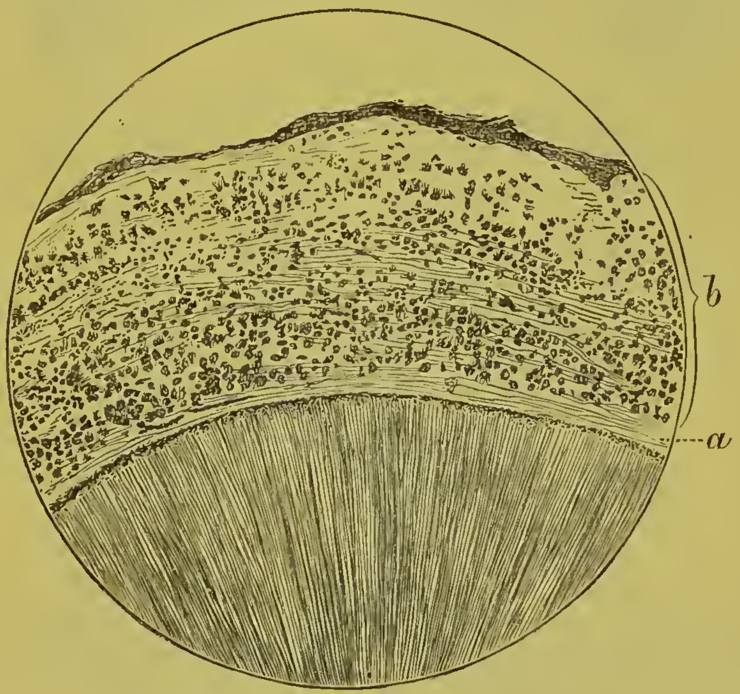
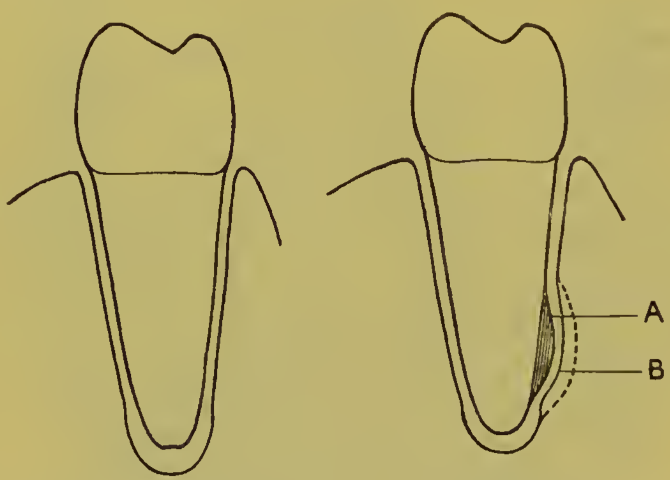


FIG. 504.—(*a*) Original layer of cementum; (*b*) tissue of new formation

Signs and symptoms.—In the early stage, before much of the tooth tissue has been removed, the principal symptom will be slight pain and tenderness on percussion, and if the inflammation is near the apex and the pulp alive, there will usually be signs of pulpitis due to extension of the inflammation. The gum covering the tooth may be swollen. As the tooth substance disappears increased looseness will be noticeable, the tooth becoming more tender, the pulp and the gum more congested. In cases of doubt a skiagram should be obtained.

Treatment.—The cause must as far as possible be removed. If the pulp is dead the canal must be thoroughly cleansed and rendered aseptic, care being taken in filling not to allow the material to pass through the apex. The tooth should be kept at rest. In the case of the premolars and molars this is difficult, but much can be done by "freeing the bite." With the anterior teeth it is a good plan to splint the affected tooth to its neighbour by means of a small cap covering the cutting edges of the teeth. Counter-irritants should be applied to the gum. In cases which do not yield to treatment and in which the inflammation continues the tooth should be removed, as the inflammation may involve the neighbouring teeth.



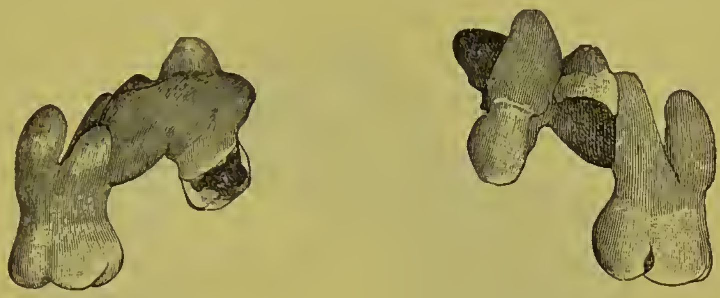
(*a*) Showing normal relation of tooth to alveolus.

(*b*) Showing changes which occur in productive periodontitis. (A) new tissue; (B) zone of rarefying osteitis.

FIG. 505.

(*β*) **Productive or proliferative periodontitis.**—In this type of chronic periodontitis the inflammatory products are replaced by fibrous or cemental tissue, the changes being similar to those occurring in a proliferative periostitis. In the more chronic forms the periodontitis is, from the first, of a proliferative character and is not preceded by a rarefying periodontitis. This is shown in fig. 504 where the original layer of cemental tissue is intact and shows no signs of having been attacked by a rarefying periodontitis. In such cases, synchronous with the formation of cemental tissue, a rarefying

osteitis occurs, and in this way room is made in the tooth socket for the new tissue (see diagram 505). In extreme cases two or more teeth may be the subjects of productive periodontitis, the intervening septum of bone may be completely removed by rarefying osteitis and the teeth become united by cemental tissue. This



(*a*) (*b*)

Fig. 506.—From a specimen in the possession of Mr. J. Colyer.

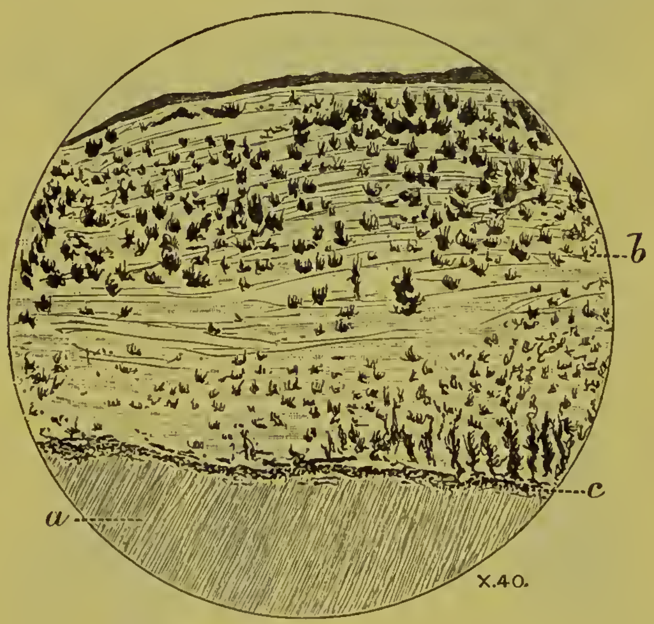


Fig. 507.—Longitudinal section, showing new tissue. (*a*) Dentine; (*b*) new tissue; (*c*) granular layer.

occurred in the case shown in fig. 506. In teeth with living pulps affected with chronic periodontitis, chronic pulpitis is usually present.

In the majority of cases a rarefying precedes a productive periodontitis. This is seen in fig. 508.

The naked eye appearances of a tooth affected by productive periodontitis are shown in figs. 509 and 510. When the inflammation is continuous and productive, the surface of the new tissue usually presents a smooth appearance, as seen in fig. 509. In cases where the condition alternates between a productive and a rarefying periodontitis, an irregular outline is usually seen (see fig. 510).

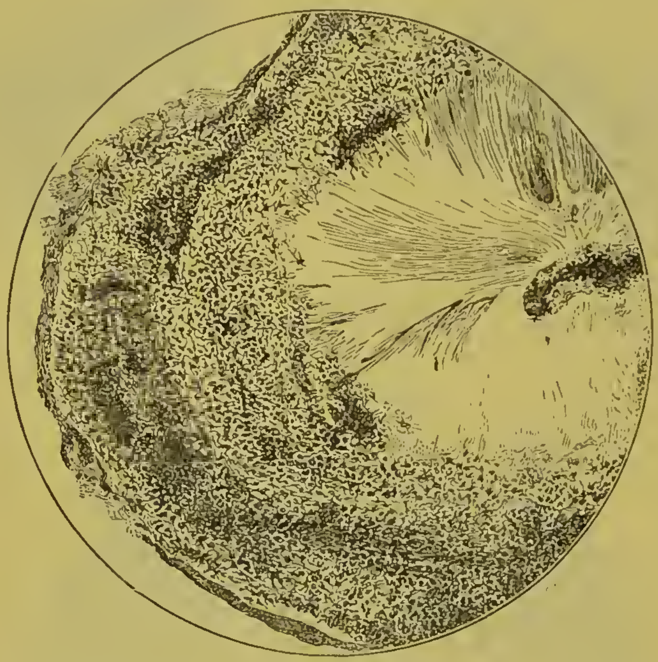


FIG. 508.—From a specimen in the possession of Mr. Douglas Caush.

FIG. 509.

FIG. 510.

The microscopical appearance of the tissue formed as a result of productive periodontitis is cemental in character. When formed as the result of a continuous productive inflammation the laminæ of the new tissue are fairly regular, the intercremental lines of Salter being usually well marked; these lines are situated at the junction

of the laminæ. The lacunæ are very numerous, and slightly larger and coarser than under normal conditions, and are fairly regularly placed (figs. 504 and 507), the canaliculi, as in normal cementum, running towards the periphery of the tooth. The new tissue may be very irregular, the laminæ not marked, and the lacunæ placed irregularly (fig. 508). Vascular canals may be met with.

Signs and symptoms.—These are frequently obscure. Usually there is slight tenderness on percussion and pain of a dull gnawing character with hyper-sensitiveness of the pulp.

Treatment.—If a septic pulp is present it must be removed and the canal rendered aseptic and filled. If the canal has been previously treated and filled it will be advisable to remove the filling if it protrude through the apical foramen, but even if this is not the case it is well to remove the filling, thoroughly treat the canals with antiseptics and refill. In cases where the pulp is living or the canals have been satisfactorily filled, one can resort to counter-irritants. If the periodontitis does not yield to treatment and the tooth is a source of constant worry it should be removed.

(γ) **Chronic suppurative periodontitis.**—In cases of suppurative periodontitis due to infection from septic pulps the poison in most instances travels to the periodontal membrane *viâ* the apical foramen. It is yet undecided if the membrane can become infected through the dentinal tubules and the lacunæ of the cementum. Miller's observations tend to show that the membrane cannot be infected in this manner, for he has demonstrated that the microbes only penetrate the dentinal tubes to a slight extent ($\frac{1}{10}$ mm., $\frac{1}{200}$ in.). Nevertheless it is quite conceivable that infection *viâ* the dentine and cementum might take place. In a chronic suppurative periodontitis the periodontal membrane becomes swollen and infiltrated with small cells which in time degenerate and form pus. Surrounding the collection of pus there is a layer of granulation tissue, the external portion of which becomes in many instances fibrous in character. As the pus collects, the tissues in the immediate neighbourhood disappear by a process of absorption, the bone being as it were eaten away. This will be seen in fig. 511.[1] In the majority of cases the outer alveolar plate is destroyed, and the pus is discharged spontaneously, a sinus remaining. A chronic abscess may increase to a certain size and remain stationary.

[1] Copied, by permission, from the *Transactions of the Odontological Society of Great Britain*

It may continue to enlarge, and in this way the maxilla may be hollowed out until it is only a shell of compact tissue. The antrum may be invaded and suppuration of the antral mucous membrane started. In the mandible the abscess tends in a like manner to excavate for itself a cavity, but the periosteum of the lower jaw frequently deposits new bone, and in this manner the mandible may become considerably expanded. The abscess as it spreads usually encroaches upon the approximal teeth and the vessels passing through the apices become affected; thrombosis occurs, and the nutrient supply to the teeth is cut off. In removing a tooth the subject of suppurative periodontitis, the "pus sac" is frequently removed in its entirety. An unusually large one (fig. 512) was recorded by Mr. Bland Sutton.[1]

FIG. 511.

The walls of a chronic dento-alveolar abscess, according to Wedl, consist of three layers: "(*a*) an external, thicker, more resistant layer, in which cells of an oblong shape, embedded in a fibrous stroma, predominate; (*b*) a middle, less firm, more succulent layer, containing principally rounded, nucleated cells, which are inserted into a mass of filaments in parallel rows or in irregular clusters; (*c*) an internal layer of a sort of granulation tissue, with the pus adherent to it."

[1] *Transactions of the Odontological Society of Great Britain*, Vol. XXVI., p. 160.

In discussing immediate root filling reference was made to cases of chronic suppurative periodontitis with sinus, in which, after practising that method of root filling, the condition was apparently cured. In such cases, if the micro-organisms are all destroyed by the action of the antiseptics, a condition may result similar to that met with in the *so-called* chronic abscess of tuberculosis, where the fluid portion of the pus is absorbed and a more or less cheesy-looking mass, consisting of cell *débris* and cholesterin crystals, remains in the capsule.

FIG. 512.—An unusually large pus-sac connected with the root of a carious first permanent mandibular molar (natural size). It is quite possible that this specimen is really an example of a suppurating dental cyst. From the *Transactions of the Odontological Society*.

In the process of suppuration the periodontal membrane may be destroyed, leading to necrosis of the cementum. There is a somewhat rare form of abscess[1] which occurs in the jaws and may be described under this heading, as it is in reality a sequel to suppurative periodontitis. Mr. J. G. Turner has drawn attention to it. The abscess may depend upon the presence of a small piece of root, and may be due to insufficient drainage after the extraction of septic teeth. Mr. Turner states that, "When the abscess occurs in the maxilla there is pain and tenderness, some swelling of soft parts, but no bony enlargement; the trouble

[1] *Journal of the British Dental Association*, p. 551, 1899.

may subside and occur again at intervals. If untreated the antrum may be involved. The nearest lymphatic glands may be enlarged. In the mandible, as in the maxilla, the alveolus may be entirely absorbed, and there is pain and tenderness and some local swelling, in this case partly of soft parts, but chiefly bony, involving the body of the jaw. Owing to the position of the inferior dental nerve there is often, especially in the premolar region, severe neuralgia. As in the maxilla, the nearest lymphatic gland may be enlarged and tender. The neuralgia is caused by the abscess in its enlargement opening up the canal of the nerve. Under these conditions there is very severe continuous heavy pain, and the more acute shooting pain which occurs at intervals without any necessary regularity; it is set up by any irritation, such as cold air, movement of eating, &c., it spreads in anatomical order to the other branches of the fifth nerve, first to the ear and then up the side of the ear to the vertex, to the infra-orbital nerve, to the supra-orbital nerve, and down the neck. It lasts a varying time, from a few seconds to hours. It is unaccompanied by trophic changes, but there may be increased secretion of tears or saliva. It is confined to the one side, and appears always to start from the seat of mischief. If the abscess has not involved the inferior dental nerve, the neuralgia will be absent."

"The length of time during which things may lie dormant varies greatly; when, therefore, a patient complains of pain or neuralgia starting in a spot where there is now no tooth, there may yet be a chronic abscess and the alveolus may be normally absorbed."

In a series of cases recorded by Dr. Hugenschmidt, of Paris, the suppurative periodontitis was apparently due to a chronic suppurating localised pulpitis, the pulp not being exposed. In one patient, a girl aged 17, a small abscess formed over the region of the right maxillary central incisor, and gradually increasing in size discharged spontaneously at the end of nine months. It was decided to open the pulp chamber, but the tooth was found so extremely sensitive that drilling could not be proceeded with and arsenic was applied. By the following day the arsenic had had but little effect, cocaine was therefore injected under the gum and the pulp cavity opened. As soon as the drill was withdrawn a bead of pus appeared at the opening. The remainder of the pulp was extirpated under cocaine and the canals filled. The suppuration in the periodontal membrane disappeared.

Dr. Kirk,[1] who has written a thoughtful paper on the subject, states that the majority of cases are met with in elderly people with teeth of hypercalcified structure and free from caries, and he regards the periodontal condition as a tophic abscess of the dento-alveolar articulation. This subject is more fully discussed on page 440, under head of Gouty Periodontitis.

Signs and symptoms. — A chronic suppurative periodontitis accompanied by a sinus will exhibit but few symptoms. The tooth is frequently free from pain, the patient only complaining of the presence of the "gum boil" which periodically swells and bursts. The sinus is usually situated over the root of the tooth. In cases of sinus on the face some little difficulty may be experienced in tracing the offending tooth, especially if two or three are pulpless or septic. A digital examination of the sulcus will often disclose a fibrous-like cord running from the base of the root to the cheek. The root or tooth causing the trouble may be buried in the gum. A sinus in the mouth in connection with suppurative periodontitis must be diagnosed from sinuses connected with necrosed bone or foreign bodies. In cases of doubt a skiagram will prove useful. When the sinus is on the face it will be needful to diagnose not only from cases due to necrosed bone or foreign bodies, but also from salivary fistula.

When a fistula is not present (chronic dento-alveolar abscess) the tooth is usually slightly tender to percussion, the amount of pain varying according to the activity of the inflammation. The gum over the root of the tooth is at times swollen and congested, but may be quite normal. A swelling can as a rule be felt well up over the apex of the tooth; this swelling is usually sensitive. In cases in which the maxilla or mandible are much involved there is often little or no pain or tenderness. A chronic dento-alveolar abscess must be diagnosed from dental cysts and other fluid swellings of the jaws (see chapter XXVII.).

Treatment.—(i.) Cases accompanied by a sinus.—When the tooth is not saveable it should be removed at once. The sinus, if opening into the mouth, will usually heal spontaneously. If the sinus is on the face or on the neck it may be necessary to stimulate the track with 10 per cent. solution of nitrate of silver, or a drug possessing a similar action. If this fails an anæsthetic should be

[1] *Dental Cosmos*, Nov., 1900.

given and the surface of the track scraped. If the tooth is considered to be saveable the canals must be thoroughly cleansed, and when possible the sinus syringed *viâ* the apical foramen. The canals should then be thoroughly sterilised and filled. The sinus, if narrow, will usually heal spontaneously after this treatment, but if not, it may be treated as suggested above. In cases where a cavity exists in the bone over the tooth, the sinus should be opened up, and the cavity scraped and packed so as to assist healing. Treatment of the sinus and the root canals does not always lead to healing, and it will frequently be found that this is due to the presence of a piece of necrosed cementum, or the deposit of some calcareous material on the surface of the root. In the case of the incisors and the canines, if the necrosis is near the apex it may be advisable to attempt excision of the apical portion of the root. With the molars and premolars extraction is usually needful, but in a few cases, if the necrosis can be located, an endeavour may be made to cure the condition by excising the root. The excision of a root should be performed as follows:—An incision is made over the root and the muco-periosteum reflected. The alveolus is then trephined so as to expose the root. It is advisable at this stage to plug the cavity thus made with some iodoform gauze to arrest the hæmorrhage. When the bleeding has ceased the plug should be removed and the portion of the root excised. A fine cross-cut fissure bur on the dental engine is the best instrument for excision, the cut being made from the distal to the mesial aspect of the root, the rough edges being trimmed with an excavator or small enamel chisel. The cavity is then syringed with an antiseptic solution and plugged with iodoform gauze. The cavity should be dressed at least once a day until it has healed by the formation of granulation tissue. In extremely obstinate cases where the removal of the tooth is most undesirable, replantation may be practised. For method of performing this operation see chapter XXI. The results obtained are usually unsatisfactory.

A depressed scar on the face may result from the healing of a sinus. In order to lessen the deformity Dr. Black suggests the following operation. The cheek is drawn aside with the finger and the exact attachment of the scar determined. A tenotomy knife is then used to separate the cicatrix from the bone; "a long pin is passed through the most depressed portion of the scar, its centre, the long ends of the pin resting upon the face; strips of adhesive

plaster laid upon the skin under the head and point of the pin will prevent the latter sinking into the soft tissues. The pin is retained for several days until the cut in the mouth heals" (Burchard).

(ii.) **Cases without a sinus—chronic dento-alveolar abscess.**—In these cases, provided the tooth is considered saveable and serviceable, the following treatment should be adopted. The abscess should be freely opened by trephining through the alveolus, and scraped. The pulp canals should then be freed of all septic matter, thoroughly sterilised and filled with gutta percha or some equally solid canal filling. The cavity of the abscess should be then syringed and plugged with iodoform gauze and made to heal by granulation. In obstinate cases excision of portion of the root or replantation may be resorted to.

(ii.) *Chronic local periodontitis commencing at the gingival margin.* **Causes.**—This condition is nearly always due to an irritant. Among the chief causes may be enumerated :—

(1) The deposit of calculi upon the teeth.
(2) Ligatures and elastic bands.
(3) Too rapid separation.
(4) The mechanical regulation of teeth.
(5) Injury during mastication.
(6) The collection of food *débris* in the approximal spaces.

Morbid anatomy and pathology.—The whole of the periodontal membrane of the tooth may be attacked when the irritant is a retained ligature or an elastic band. The gum around the tooth is swollen, congested and painful, the inflammation spreads to the periodontal membrane. By a process of ulceration the membrane is gradually destroyed, the root laid bare, and in time the apical vessels are involved, leading to pulp complications. The inflammation may be partial, *i.e.*, the periodontal membrane on one side of the tooth only may be attacked. This condition is seen in the mandibular incisors on the labial aspects where, owing to deposits of calculus, the membrane is occasionally destroyed to the apex of the root. The most important form from a clinical point of view is that met with in the region of the premolars and molars. A space may exist between the posterior teeth and food, especially meat, become wedged between the teeth during mastication. The pressure thus exerted starts chronic periodontal inflammation which in time leads to the destruction of the tissue, and the inflammation, if not treated, will gradually involve the membrane up to the apex of the root.

In other cases the teeth may approximate at the occluding surfaces, but, owing to a slight recession of the gum, food works its way between the approximal spaces during mastication. Unless great care is taken in removing these particles of food a progressive ulceration of the periodontal membrane is started. The membrane is destroyed in a cup-shaped manner, as seen in the diagram (fig. 513), forming pockets, the gum apparently filling up the approximal spaces (fig. 514).

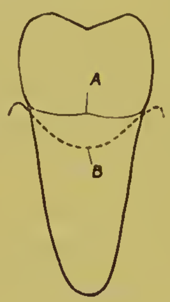


FIG. 513.—(A) Neck of tooth and normal attachment of gum; (B) margin of gum.

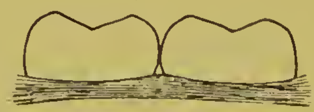


FIG. 514.

The destruction of the membrane proceeds until the apical vessels are involved. A destructive inflammation is then started in the pulp.

Signs and symptoms.—Slight tenderness during mastication, with pulp pain from thermal changes (owing to exposure of the cementum) are the chief symptoms. *In cases due to ligatures or elastic bands*, the gum shows signs of inflammation and pus can usually be squeezed up round the neck of the tooth. There will be pain to thermal changes. *In cases due to pressure from mastication* there is extreme tenderness, the gum is swollen and congested, and the tooth tender to pressure.

When a pocket exists and the occluding surfaces are in contact, the tags of gum on the labial and palatal aspects of the approximal space appear slightly congested, but the recession from the space is in many cases but slightly marked. The patient complains of slight discomfort from food wedging between the teeth and, if there is pain

to thermal changes an examination with a suitable probe will show a considerable destruction of the periodontal membrane, the root of the tooth being frequently denuded to at least half its length.

The diagnosis presents little difficulty. An inflamed condition of the gum, slight tenderness on percussion and pain on touching the exposed cementum are sufficient evidence; care must, however, be taken to exclude pulp irritations from other causes.

Treatment.—*In the cases arising from ligatures, elastic bands, tartar, &c.*, the cause must necessarily be removed. The socket is then syringed out with a suitable antiseptic (hydrogen peroxide, 20 vols.) and the ulcerated surface treated with some mild escharotic, such as trichloracetic acid (25 per cent. solution).

In cases due to pressure from mastication careful contour fillings must be made in the approximal surfaces of the teeth (see p. 295) and the exposed cementum treated with nitrate of silver. When the periodontitis is *traceable to the lodgment of food simply*, and is not due to pressure from mastication, the approximal space should be syringed and the surface of the gum cauterised with nitrate of silver. This drug will serve a double purpose, namely, to reduce the sensitiveness of the cementum and at the same time to promote the formation of healthy granulations in the approximal space. The application by the patient of tincture of iodine every day for a week will result in the disappearance of the pocket and the formation of a space which can be easily kept free from the *débris* of food by a suitable tooth-pick.

(2) GENERAL PERIODONTITIS.

(*a*) **Acute.**—(i.) *Starting at the apices or on the lateral surfaces of the roots.*—In this condition the inflammation involves several teeth as well as the contiguous periosteum of the bone. A general inflammation of the whole alveolar periosteum has therefore to be dealt with. The condition may have its origin in the periodontal membrane or in the muco-periosteum. The teeth become loose and sensitive to touch. The muco-periosteum is swollen, deeply congested and painful to pressure. The inflammation may resolve, but suppuration is very likely to occur unless prompt measures are taken to relieve the congestion. If suppuration occurs the periosteum becomes separated from the bone, with the result that necrosis supervenes; occasionally the inflammation passes into a chronic

form, and this is more particularly seen in gouty and rheumatic types.

Causes.—General periodontitis may arise in people exposed to the fumes of phosphorus (see necrosis of the jaws). The prolonged administration of mercury and certain other drugs may be cited as a cause. It may arise from injury in patients the subjects of syphilis, gout, or rheumatism, or may follow on one of the exanthematous fevers.

Signs and symptoms.—The local signs and symptoms are similar to those of the local form, except, of course, that several teeth are involved in the process. Pain of a dull gnawing character is present, and is frequently intense when the patient is of a gouty or rheumatic diathesis. There will be general symptoms of pyrexia. Suppuration, if it occurs, is usually ushered in by a well-marked rigor, and the local pain becomes of a throbbing character.

Treatment. *Local.*—The application of poppy-head fomentations with scarification should be practised. The mouth should be kept as aseptic as possible, and any septic roots present should be removed.

The *general* treatment will depend upon the cause. A smart saline purge should be administered in nearly all cases. If due to syphilis, iodide of potassium must be given, while cases of gouty and rheumatic origin call for the general treatment of those affections. If the inflammation shows a tendency to suppurate, free incisions must be made down to the bone, followed by the constant use of fomentations.

(ii.) *Commencing at the gingival margin.*—In the condition just described the inflammation attacks the periodontal membrane generally. Certain types are, however, met with which start at the gingival margin, or rather arise from an extension of a gingivitis. These cases of acute general suppurative periodontitis commencing at the gingival margin form **one of the clinical varieties of the condition termed "pyorrhœa alveolaris."** If a patient suffering from this condition be examined, the margins of the periodontal membrane will be seen to be in a state of acute suppuration. Pus will be found welling up around the necks of the teeth, the roots of which will be exposed if the case has been in progress some time. The muco-periosteum will be more or less involved. If left untreated, loss of the teeth and extensive necrosis may occur. The condition may commence simultaneously in a large number of the

teeth, or may arise in connection with one, and rapidly spread to the others. In one patient under treatment there was an acute suppurative periodontitis, which had spread from the left maxillary first molar backwards to the third molar and forwards to the canine, the distal portion of the latter tooth, when first seen, being involved in the inflammation and the mesial being quite free. The source of irritation was a loose crown. The patient was a syphilitic subject.

Treatment.—The sockets of the teeth should be thoroughly irrigated with an unirritating antiseptic solution, *e.g.*, perchloride of mercury (1 in 1000) or peroxide of hydrogen (20 vols.). Any irritant such as tartar, a badly-fitting denture, &c., should be removed. An astringent and antiseptic lotion should be prescribed for frequent use by the patient. The pockets around the teeth should be syringed every day until healing occurs. If at all intractable a solution of trichloracetic acid (25 per cent.) should be applied to each socket. The general health must receive attention. In the case of syphilitic subjects iodide of potassium should be administered.

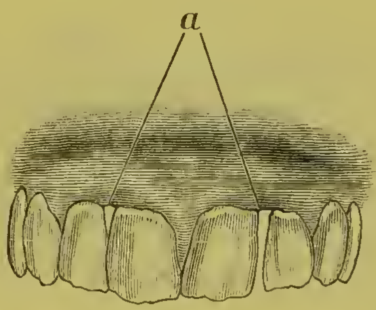


FIG. 515.—From the "American System of Dental Surgery."

(*b*) **Chronic general periodontitis.**—Chronic general periodontitis commencing at the gingival margin is always secondary to a gingivitis; by this it is not to be inferred that all cases of gingivitis go on to periodontitis, but rather that in all cases of this form of periodontitis the gingival margin is first attacked. Gingivitis is dealt with under the heading of "Diseases of the Gums," and the student is advised to study the account there given before reading the following pages.

In the early stages of chronic general periodontitis the margins of the gums appear puffy and congested, the patient complaining that they bleed readily. The tag of gum between the teeth gradually disappears, the normal festoon being obliterated (fig. 515). A fine

probe passed under the margin of the gum will disclose a small nodule of calculus, especially in the approximal spaces. If the gums are compressed, a small quantity of pus may be seen escaping by the side of the tooth. The destruction of the membrane by ulceration continues, at the same time a rarefying inflammation occurs in the alveolus, and the muco-periosteum, having lost its attachments, gradually recedes. The recession of the gum does not usually proceed as quickly as the solution of the alveolus, the result being that deep pockets containing pus and other products of inflammation exist around the necks of the teeth. With the destruction of the sockets the teeth become loose, and this increased mobility tends to aggravate the inflammatory process, the teeth becoming so loose that they can be removed quite easily. The membrane may be destroyed symmetrically around the teeth, or this destruction may start at one point, and proceeding in a downward direction, may completely lay bare the tooth on one side only from its neck to its apex.

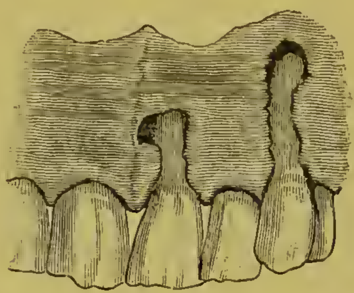


FIG. 516.—From "The American System of Dental Surgery."

In many cases it is stated that as the destruction advances in a longitudinal direction it also widens (see fig. 516).

In some patients the disease is much more active on the lingual and palatal aspects of the teeth than the labial and buccal. This is more particularly noticeable with the superior incisors and canines. The inflammation varies considerably in its intensity, and is dependent upon the general condition of the patient and the hygiene of the mouth. At one period the inflammation may border on an acute condition, pus flowing freely from the tooth sockets, and the destruction of the tissue being rapid; this state of evanescence is perhaps followed by a period in which the inflammation may be but slightly marked and perhaps arrested. When the disease has

passed into this stage the gums, especially in gouty patients, frequently present an anæmic appearance; no pus can be demonstrated on pressing the gum, and the margin of the alveolus appears thickened from a productive periostitis (see fig. 516A).

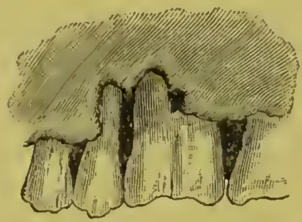


FIG. 516*a*.—From "The American System of Dental Surgery."

In some cases the inflammation appears catarrhal in type.

The morbid anatomy of this type of chronic periodontitis is well seen in the following figure taken from a skull in the museum of the Odontological Society. Attention is drawn to (α) the nodules

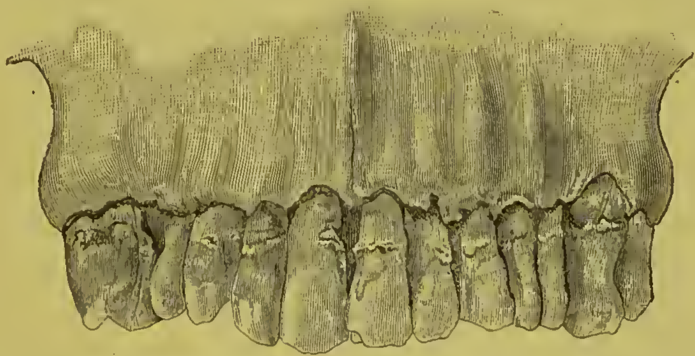


FIG. 517.—Showing the teeth and alveolar process of a patient who suffered from chronic suppurative periodontitis.

of calculus placed some distance from the seat of inflammatory activity; (β) the cup-shaped destruction of the bone by rarefying osteitis; (γ) the thickening of the margin of the alveolus externally from a productive periostitis.

There is a variety of chronic periodontitis which is but slightly affected by the general health, the destruction of the periodontal membrane and alveolus being due to the deposit of the calculus, general conditions playing but a slight part in the disease. This condition is usually seen in mouths which have been much neglected by the patient. There is a thick deposit of calculus on the teeth,

especially on the labial and buccal surfaces. The deposit acts as an irritant, and sets up in the periodontal membrane an inflammation of a very chronic but probably ulcerative character. Pus cannot usually be discovered around the necks of the teeth. The deposit of calculus and destruction of the membrane and adjacent alveolus may continue until the teeth become loose through lack of support and are easily removed. The gum will frequently be found to be slightly inflamed. The inflammation of the periodontal membrane may become more acute and infection takes place, producing an active suppuration.

Causes.—In the large majority of cases *general systemic conditions play an important part.* The rise and fall in the state of general health will be found to synchronise with an improvement and deterioration in the condition of the mouth. Subjects of the uric acid diathesis seem to be specially liable to chronic periodontitis (this question is fully dealt with on pp. 440 to 444); it is also frequently met with in the rheumatic and diabetic. Any disease which produces a general lowering of vitality, *e.g.*, chronic nephritis, tubercle, &c., must be regarded as a predisposing cause. Severe fevers, such as typhoid, may act as a predisposing cause. The poison which produces the fever probably causes the cloudy swelling of the fibrous tissue which is noticed in the diseases attended by pyrexia. Cloudy swelling is often followed by fatty degenerative changes, and the resistance of the tissue is thereby lowered. Among the **local predisposing causes** may be enumerated previous attacks of inflammation and the mechanical regulation of teeth. **The immediate or exciting cause** is frequently the deposition of calculus under the gum margin. This calculus is probably the result of gingivitis (see p. 462). *Débris* of food, badly adjusted artificial dentures and injury from the opposing teeth (as seen in cases where the inferior incisors impinge on the gum posterior to the superior incisors) may also act as exciting causes. In some cases the periodontitis is an extension of inflammation from gingivitis. It is interesting to note that removal of the affected teeth produces a cure. **Chronic general periodontitis is to be regarded in the same light as chronic inflammation in other parts of the body.** The inflammation is due to a local irritant acting on a tissue predisposed to inflammation. Under certain conditions the tissues may be infected with pyogenic organisms, with the result that a suppurative process is started. Why, in general systemic conditions, the periodontal membrane

should be more liable to attack than the other parts of the body is difficult to account for. Talbot[1] inclines to the view that the susceptibility is due to the fact that the alveolar process and periodontal membrane are "transitory and adventitious structures," and are therefore more predisposed to disease than permanent structures. It is also possible that the degenerative changes which have affected the structure of the teeth have had a like influence on the periodontal membrane. Some responsibility rests no doubt with our modern system of cooking, which, by depriving the jaws of work, diminishes their supply of blood; the decreased blood supply would especially affect the periodontal membranes. Insufficient blood supply from disuse is a constant predisposing cause of inflammation. It must also be remembered that local sources of irritation are more frequently met with in the mouth than in any other part of the body.

Treatment.—*Local.*—This will depend to a great extent upon the intensity of the inflammation. With much congestion of the gums and active pus formation the first stage consists in the removal of all calculus or other matter from the surfaces of the teeth (for the method of removing calculus see chapter XV.).

The pockets around each tooth should at the first visit be syringed with hydrogen peroxide (20 vols), and the gums treated with an astringent, and for this purpose powdered tannic acid may be gently rubbed in, both on the inner and outer aspects of the alveolus. The hydrogen peroxide acts as a germicide, and the oxygen set free, on rising to the surface, brings with it a good deal of *débris* from the "pockets," and so acts as a mechanical cleansing agent. The astringent reduces the inflammation of the gum. The patient should be instructed to apply the astringent to the gums morning and evening. An antiseptic mouth wash should be prescribed to be used several times a day, at least after each meal. At the end of three days each socket should be again syringed with peroxide of hydrogen. Any calculus which may have escaped at the first visit should then be removed. In order to free the surfaces of the roots entirely from *débris* each tooth should be treated with a solution of trichloracetic acid (25 per cent.). This is applied on a thin wedge-shaped piece of wood. Each socket is gently treated, the acid destroying the semi-necrosed soft tissue and freeing the

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[1] *International Dental Journal*, February, 1900.

root surfaces of any minute particles of calculus. The use of antiseptic washes and the application of the astringent, with periodical syringing of the sockets, usually results in a marked improvement in the course of three or four weeks. Massage of the gums with the finger will be found advantageous. Attention must be directed to the general health—when thoroughly restored the periodontitis will be in many cases arrested and cured. Where, however, any chronic condition exists, such as diabetes or chronic nephritis, there is but little chance of effecting a cure; the utmost that can be hoped for is to lessen the activity of the disease by frequent removal of the calculus and the regular use by the patient of astringent and antiseptic mouth washes. By these means the teeth may be retained for many years. In a case of this kind which has been under observation for ten years, the patient suffering from diabetes, the actual destruction of the tooth attachments has been almost arrested. Teeth which become very loose and are not amenable to treatment should be removed.

When the inflammation is very chronic in type, and there is little or no pus formation, it is at times advisable to use more powerful remedies. Pure sulphate of copper may be packed into the gum pockets with a thin piece of wood, or dilute aromatic sulphuric acid may be used. For cleansing the teeth, tooth soaps should be used in preference to powders, as there is always a risk of the insoluble portions of the powder finding their way into the gum pockets and acting as irritants.

(3) GOUTY PERIODONTITIS.

Under this heading it is proposed to refer to that form of chronic periodontitis which is closely associated with the uric acid or gouty diathesis. It has formed the subject of much discussion, and divergent views are still held as to its pathology.

It is probable that in the majority of cases the destruction of the membrane progresses from the gingival margin to the apex, but even in this variety there are frequently signs that the whole of the membrane is affected. In other cases the periodontitis is said to commence on the surfaces of the roots, at or near the apex, and the destruction to proceed towards the gingival margin. Many practitioners stoutly deny that the disease proceeds under any

circumstances from the roots to the gingival margins, but there is nevertheless strong clinical evidence that at times it does take this course. Gouty periodontitis seldom manifests itself before the age of 30, in most cases the patient has reached the age of 45 to 50. There is usually a well-marked history of hereditary gout. The teeth are often free from caries, and show signs of well-marked attrition. In the earliest stages there is a gingivitis, and subsequently the periodontal membrane becomes involved, causing more or less recession of the gums and absorption of the alveolar process. The mouth may remain in this condition for years. **The margin of the gums often presents a thickened appearance**, which is probably due to a productive inflammation of the muco-periosteum. An examination of the sockets with a probe will not disclose any deep pockets, or much calculus. At intervals synchronous with a lowering of the standard of general health, the gums will appear congested, a catarrhal-like discharge or even pus may exude from the pockets, and the teeth will become sensitive to pressure, the inflammation, on examination, appearing to involve the whole periodontal membrane ; the teeth will be hyper-sensitive to thermal changes, and the patient will often complain of shooting pains in the region of the alveolus. The oral condition improves with that of the general health, leaving the roots of the teeth a little more exposed. **The attacks tend to become more frequent as age advances**, and one or two teeth during an attack are singled out, as it were, for an extra dose of the specific poison. The inflammation in the tooth or teeth may stop short of suppuration, but even when a general improvement has taken place a distinct looseness of the tooth or teeth persists. During a subsequent attack the tooth becomes extremely loose, and the gum overlying the upper half of the root may become swollen and a fluctuating swelling appear. An incision into the swelling will disclose a glairy, mucus-like fluid or even pus.

If the swelling is not incised, it may break externally or the fluid may wend its way towards the gingival margin and so discharge at the neck. An examination of the tooth will disclose a living pulp. In such teeth a rapid destruction of the periodontal membrane and alveolus takes place, and the tooth becomes quite loose and is lost. With the advance of years the attacks occur with increasing severity, the teeth becoming loose partly by the destruction of the membrane commencing at the gingival margin, and partly by acute exacerbations in one or two teeth as mentioned above.

Doubt exists in the minds of many pathologists as to whether this variety of periodontitis is of systemic origin, as claimed by Dr. Pierce. It will be well therefore briefly to state the views for and against. Dr. Pierce attributes the cause of the periodontitis to the plasma exudation from the blood vessels freighted with salts which are deposited on the surface of the cementum and act as irritants. The salts in question are calcium and sodium urates, free uric acid and traces of calcium phosphate. These salts are stated to be most frequently deposited in the region of the apex. In the immediate neighbourhood of the calculus inflammation takes place, and with fresh deposits of calculus the area of inflammation

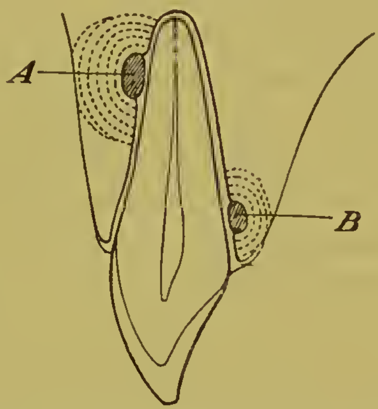


FIG. 518.—*A* and *B* show deposits of calcareous matter surrounded by zones of degeneration.

and degeneration is enlarged. The tissue breaks down and the pus gains an exit either by the gum or around the neck of the tooth, the situation mainly depending upon the seat of primary lesion. This is diagrammatically shown in the above fig. 518, from a paper by Dr. E. C. Kirk (*Cosmos*, November, 1900, p. 1150). This author considers that this type of periodontal abscess is the typical lesion of gouty periodontitis. When the abscess has opened externally infection from the mouth takes place. But it is also possible that the pus from these periodontal abscesses may contain infecting organisms. In four examined by Kirk the pus in each one contained the diplococcus of pneumonia, and in two of the cases the infection was an absolutely pure culture. It is maintained by some observers that periodontal abscesses cannot arise in this manner, and that in all cases where suppuration occurs in connection with living

teeth there is a primary breach of surface through which the pyogenic organisms gain entrance. Dr. Kirk, who is a most careful observer, on the other hand states that he has seen between fifteen and twenty cases of this character, and in practice cases are met with in which one is unable to find any separation of the membrane from the neck of the tooth.

We are therefore inclined to agree with Dr. Kirk that certain of the lesions seen in gouty periodontitis arise in the manner he describes, although we have been unable to satisfactorily demonstrate the presence of urates, to which reference will now be made.

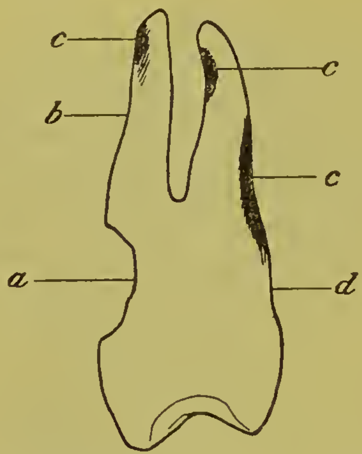


Fig. 519.—Tooth removed from a patient suffering from acute gouty periodontitis. Chemical examination of the calcareous deposits failed to demonstrate the presence of urates. (*a*) Cavity due to abrasion; (*b*) marks the limit to which the root was exposed; (*c*) calcareous deposits; (*d*) marks limit of recession of gum on palatal aspect.

Pierce and others maintain that the deposit so often seen on teeth removed from gouty subjects contains urates, which can be easily demonstrated by the murexide test. Burchard states that the reaction of the urates is masked by the presence of calcium phosphate deposits.

Dr. Talbot, in a paper before the Academy of Stomatology of Philadelphia, January, 1896, states that in 215 cases of teeth examined with calcic deposits, twelve gave a positive reaction with the murexide test. It is to be noted, however, in this series of tests that no apparent precautions were taken to examine only teeth from cases of periodontitis in gouty people, and hence the value of these researches is somewhat discounted.

Dr. Galippe, in an examination of forty teeth (*Journal des Connaisances Medicales*, quoted in *L'Odontologie)* chosen from patients with suppurative periodontitis, was unable to demonstrate the presence of urates, but here, as with the researches of Talbot, no care seems to have been taken to examine only teeth from gouty subjects.

The presence of urates in a gouty condition is still an open question. If their presence can be demonstrated in the majority of cases of periodontitis occurring in the gouty, the view advanced by Pierce that the condition is purely constitutional in origin would appear reasonable. Whether urates are present or not there can be but little doubt that the mouth condition is to a very great extent dependent on the general condition. One patient under my observation, the subject of gout, invariably suffers from a general tenderness in the teeth and a feeling, as he describes it, of "stiffness" in the metacarpal-phalangeal joints whenever he contravenes the rigid rules of dietary which must be observed by the gouty. Again, the peculiar intractability of the condition to local treatment and the rapid improvement when a general course of treatment is undertaken, is sufficient alone, from a clinical point of view, to demonstrate the apparent constitutional cause of the condition.

Treatment.—Locally, the line of treatment recommended on p. 439 should be pursued. The general treatment is that of gout, and falls within the realm of the physician.

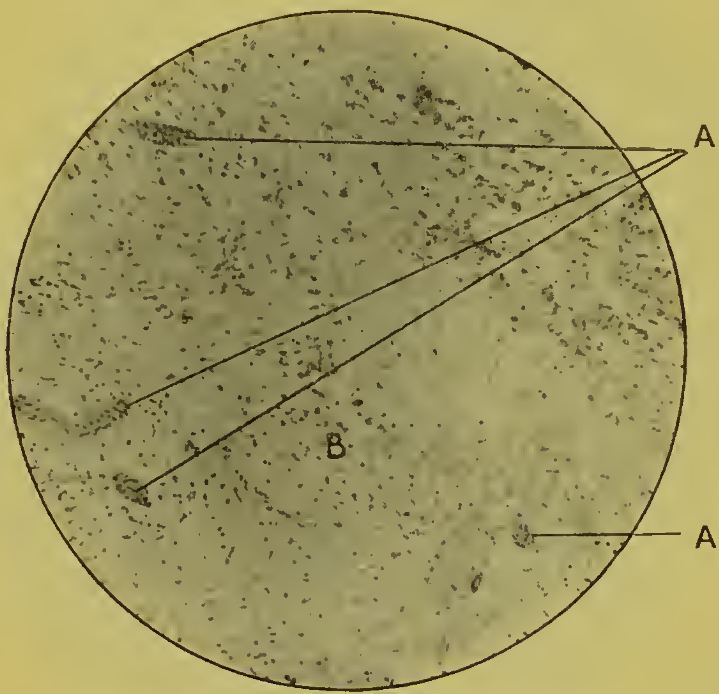
B.—NECROSIS OF TEETH.

A tooth derives its nutritional supply from two sources, namely, the pulp and the periosteum. When the death of the pulp alone occurs a **partial necrosis of the dentine** takes place. From a clinical point of view this is unimportant and does not give rise to any symptoms if the canal is properly treated. When, in addition to death of the pulp, the periodontal membrane becomes separated from the cementum, **partial** or complete necrosis of the tooth takes place. **Partial necrosis of the cementum** is common, and is generally the result of suppurative periodontitis. A curious condition at times is seen where a single root of a molar is laid bare (more commonly the palatine); but such a condition does not as a rule give rise to any trouble, and therefore calls for no treatment. In cases of **complete necrosis of the cementum**, the tooth becomes a foreign

body, sets up irritation and ulceration and should therefore be removed.

C.—TUMOURS.

In the course of chronic periodontitis, whether arising from apical infection or from infection from outside at the neck of the tooth, interstitial granulation tissue is found, often in considerable amount, infiltrating the alveolar-dental ligament and absorbing and replacing surrounding bone. This tissue consists, as does granulation tissue



x 100, ½ in. obj., N.A. ·4.

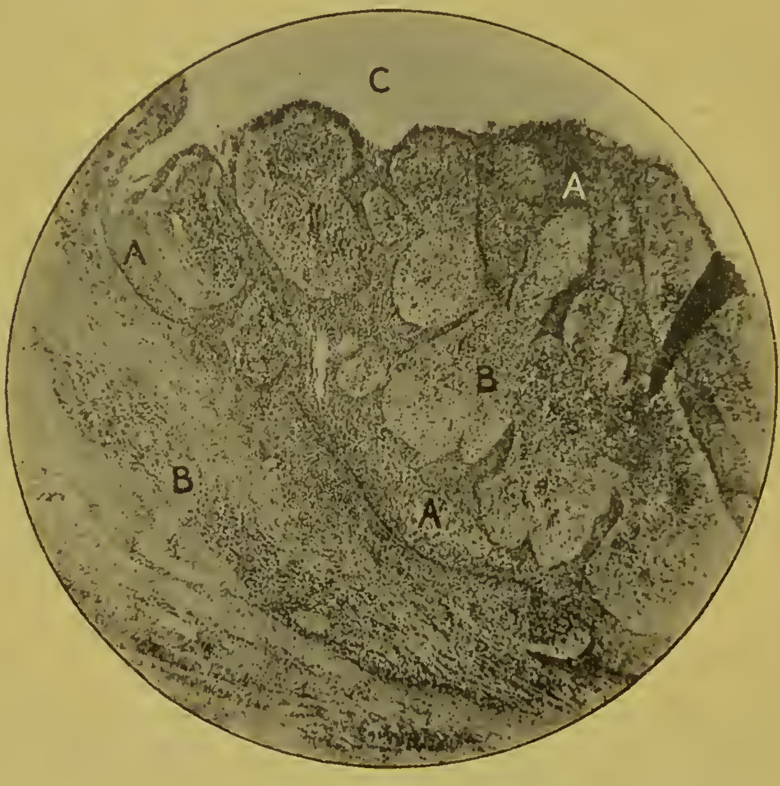
FIG. 520.—Section of thickened alveolar dental ligament from near apex of tooth. A, masses and cylinders of epithelium; B, inflammatory tissue.

elsewhere, of small round cells and blood vessels, with, when occurring in connection with osseous tissues, a certain, and in some cases excessive, number of osteoclasts or giant cells. Interspersed among the granulation tissues are found remains of the original tissue of the part, the cells of which have in some cases proliferated, and it is in the midst of this granulation tissue that the epithelial masses forming the first rudiments of dental cysts are found (see above, fig. 520). The presence of large numbers of myeloid cells suggests

that some cases of myeloid sarcoma of the jaws have their origin in this granulation tissue, and the same is extremely likely to be the case with other varieties of sarcoma met with in the jaws.

(1) CYSTS.

Cysts connected with the roots of fully developed and erupted teeth are called "dental cysts." The nature of these tumours has been carefully investigated by Mr. J. G. Turner.[1] Dental cysts are the commonest tumours of the jaw and the commonest cysts of bone.



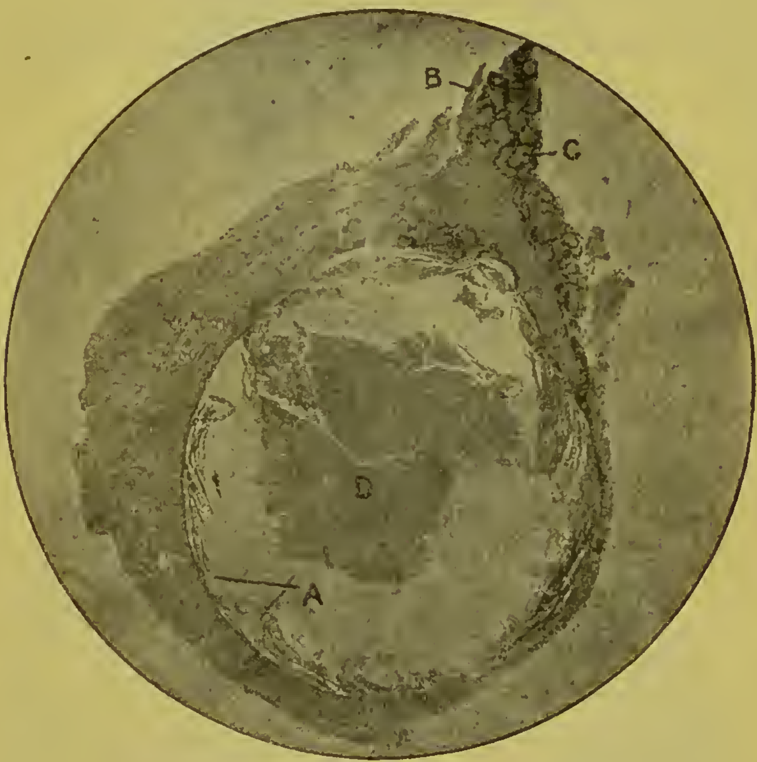
× 30, $1\frac{1}{2}$ in. obj., N.A. ·15.

FIG. 521.—Section of part of an epithelial root-tumour; C is placed in central cleft. A, trabeculæ of epithelial reticulum, central cells degenerating; B, mesoblastic tissue.

(*a*) **Etiology.**—They probably arise from the masses of epithelium which are met with in the periodontal membrane and which have been termed by Malassez **para-dental epithelial remnants.** The formation and shape of the dentine of a root is determined

[1] *Journal of the British Dental Association*, October, 1898.

by a prolongation of the enamel-forming organ known as the epithelial sheath of Hertwig. On the formation of the dentine the surrounding mesoblastic cells invade and partly destroy the sheath, and, applying themselves to the surface of the dentine, form the cementum and alveolar dental ligament (periodontal membrane). Portions of the sheath remain at times undestroyed and these form the para-dental epithelial remnants.



x $9\frac{1}{4}$, 3 in. obj., N.A. ·1.

FIG. 522.—Section of a small cyst attached to the apex of a root. A, epithelial lining; B, mass of epithelium; C, remains of epithelial reticulum; D, semi-solid contents.

The development of a dental cyst can always be traced to irritation from a septic tooth, even though the tooth may have been lost. Of the twenty-five cases recorded by Mr. J. G. Turner, in which it was possible to ascertain the tooth which originated the cyst, nineteen were in the maxilla and eight in the mandible. The cysts occur most frequently in connection with the molar teeth.

(*b*) Morbid anatomy and pathology.—The formation of a dental cyst probably takes place as follows :—The epithelium composing

one or more (fig. 520) of the aberrant masses proliferates and this eventually leads to the formation of a solid tumour, "epithelial root tumour," the epithelial portion of which is sometimes in the form of a solid mass, but usually is found as a reticulum or spongework (fig. 521).

The cells on the periphery of the mass are in a state of active growth, while those towards the centre are in a process of degeneration. Around this epithelial mass a capsule is developed from the surrounding mesoblastic cells. The cells towards the centre of the mass in time degenerate and liquefy, forming a distinct cyst. (See fig. 522.)

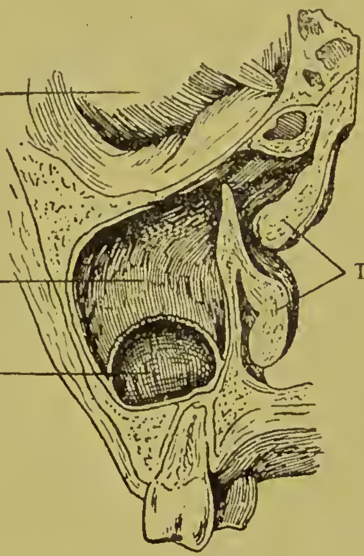


FIG. 523.—Cyst connected with a molar root presenting in the antrum, the floor of which is pushed in, thinned, and the bone perforated in places.
(*From a specimen in the Royal College of Surgeons' Museum.*)

The cells at the periphery continue to multiply and increase in size, shedding themselves towards the centre and at the same time undergoing a liquefying degeneration. Thus are formed the fluid contents of the cyst, and by growth at the periphery and degeneration at the centre the enlargement of the cyst is explained.

Being a fluid growth the cyst will displace the tissues and enlarge in the direction of least resistance.

In the maxilla the outer plate is generally pushed out, thinned and expanded, and eventually perforated at the most prominent part, and the same occurs, though far less frequently, in the hard

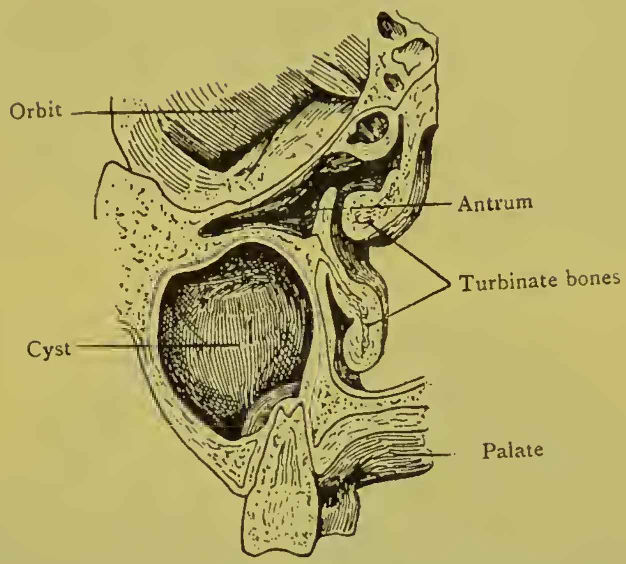
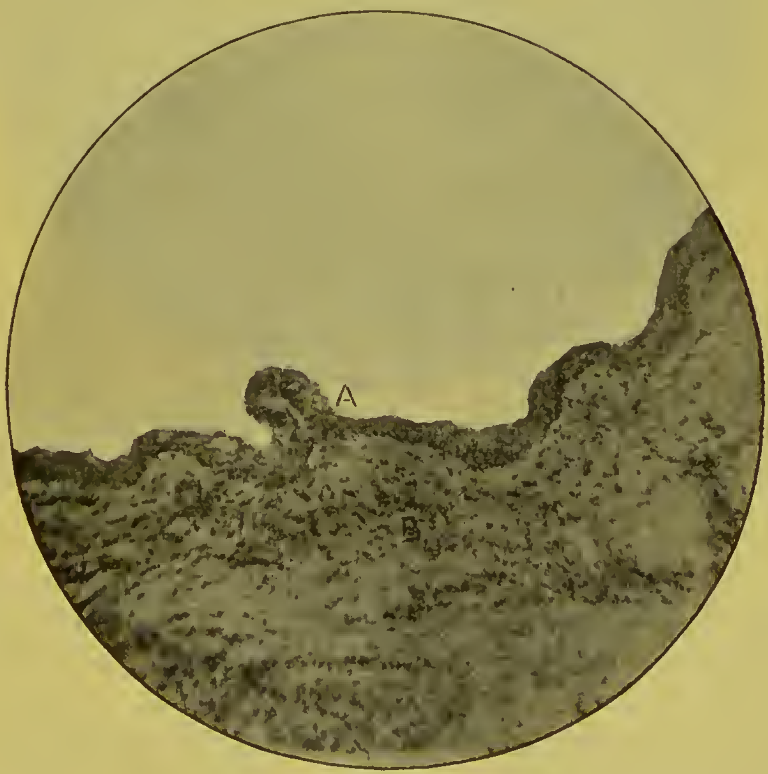


FIG. 524.—Dental cyst pushing up antrum till it is a mere slit beneath orbit. Modified from Zuckerkandl.

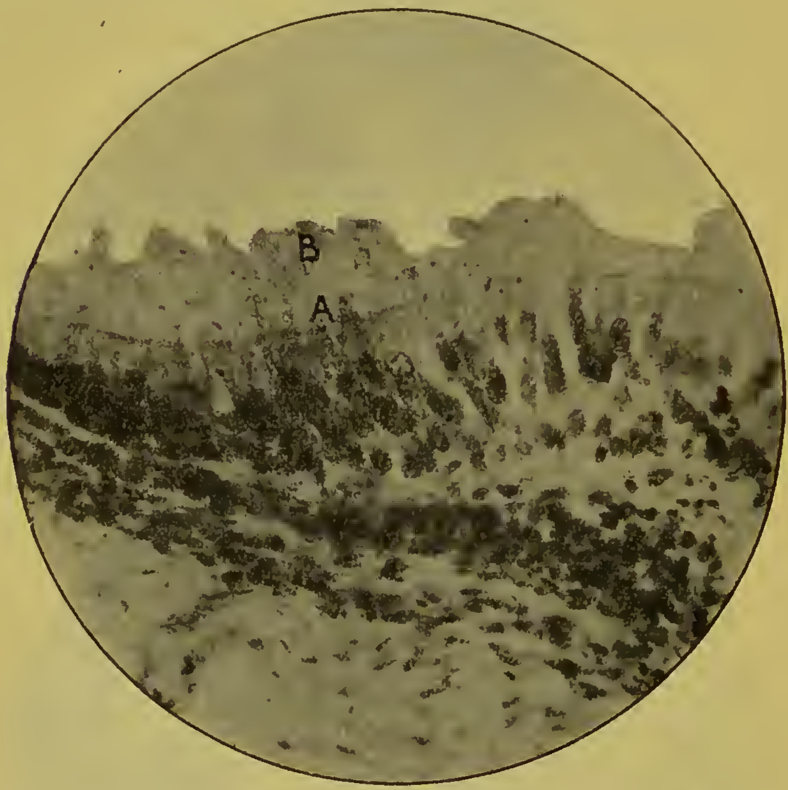


× 110, $\frac{1}{6}$ in. obj., N.A. ·4.

FIG. 525.—Section of wall of large dental cyst. A, thin regular lining of epithelium; B, connective tissue capsule.

palate. The cyst frequently encroaches on the cavity of the antrum in exactly the same manner, the bony floor being pushed in, expanded, thinned, and perforated (see fig. 523), but in some instances the whole floor is pushed up till the antral cavity is almost entirely obliterated (fig. 524).

In the incisor region, a cyst may present in the incisive fossa and encroach on the floor of the nose.



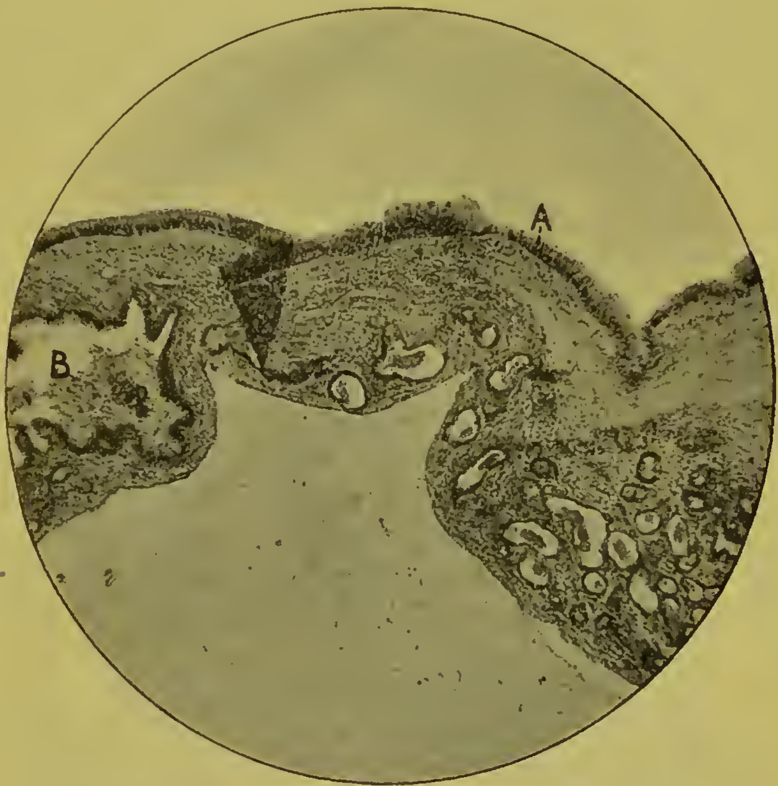
× 350, $\frac{1}{8}$ in. obj., N.A. ·6.

FIG. 526. Part marked A in fig. 525 highly magnified. A, cilia; B, products of degeneration or secretion.

In the mandible, the outer plate again is the more generally expanded and perforated, but where the cyst is of large size both plates will suffer, and cysts have been seen presenting on the inner side only.

According to Mr. Turner, if the cyst in its growth comes across the root or roots of teeth it does not bare them of their living surroundings. Further, the root from which the growth arises never projects bare into the cavity of the cyst.

Contents.—A dental cyst contains a viscid, translucent, mucus-like fluid, with also crystals of cholestrin in suspension. *Chemical examination*, according to Mr. Turner, shows the presence of proteids in the form of serum albumen and serum globulin, the latter being more abundant. There is an abundance of cholestrin, but no fats or fatty acids. A small quantity of nucleo-albumen is also present.



× 43, $1\frac{1}{3}$ in. obj., N.A. ·15

FIG. 527.—Section of wall of dental cyst, columnar ciliated epithelium and loculi (embedded in celloidin). A, columnar ciliated epithelium; B, large irregular acinus; C, smaller acini and tubules.

Structure of the cyst wall.—A section through the wall of a dental cyst shows an outer layer of connective tissue, which forms the capsule. This is lined with epithelium, which is in some cases of the stratified variety (fig. 525), while in other examples the cells tend to assume a stellate form and are similar in appearance to those of the body of the enamel organ. The cells immediately bordering the cavity are in a state of degeneration (not colloid). Occasionally columnar ciliated epithelium is met with (fig. 526).

In some cysts the epithelial cell growth may be very active, and the connective tissue wall may be very thick and approach in structure a multilocular cystic tumour, in which one loculus has far exceeded the others in growth (see fig. 527).

(*c*) **Signs and symptoms.**—Dental cysts give rise to smooth, globular swellings. The growth is slow but progressive. Inflammatory symptoms are usually absent, the mucous membrane being freely movable over the surface of the tumour. Occasionally dental cysts suppurate, and the symptoms of pus formation will then be added to the physical signs of tumour growth. Pressure on the surface of the swelling will frequently produce a peculiar sensation of crackling, demonstrating the presence of a thin layer of bone. Often the cyst makes its way through the bone, and then distinct fluctuation can be obtained; the fluctuating area being frequently bounded by a bony edge. *The differential diagnosis* from other swellings in the jaw is dealt with in chapter xxvii.

(*d*) **Treatment.**—The septic roots must be removed. The cyst should then be thoroughly opened by removing a considerable portion of the outer wall. The contents of the cyst must then be removed, and the walls dissected out or scraped away. This must be done thoroughly, for if any portion of the wall be allowed to remain recurrence may take place. The cavity of the cyst should be packed lightly with iodoform gauze for the first twenty-four hours and the surface allowed to granulate over.

(2) EPITHELIAL ROOT TUMOURS.

In the early stages a dental cyst consists of a mass of reticulum of epithelium enclosed in a capsule of more or less perfectly formed connective tissue, and forms a small tumour such as is frequently found attached to a septic root on extraction. Such a tumour (fig. 521) is called **an epithelial root tumour.** Their frequency is such as to suggest that many of them undergo involution and absorption. It is also probable that they are the starting point of some of the carcinomata of the jaws.

(3) FIBROMATA.

Certain varieties of so-called "pedunculated epulides" must be regarded as fibrous tumours of the periodontal membrane. In figs. 528 and 529 two such tumours are shown. They are attached

FIG. 528.—Mandibular canine, with tumour adherent to the periodontal membrane. From a case under the care of Mr. Truman.

FIG 529. — Mandibular premolar, with tumour adherent to the periodontal membrane. From a case under the care of Mr. Truman.

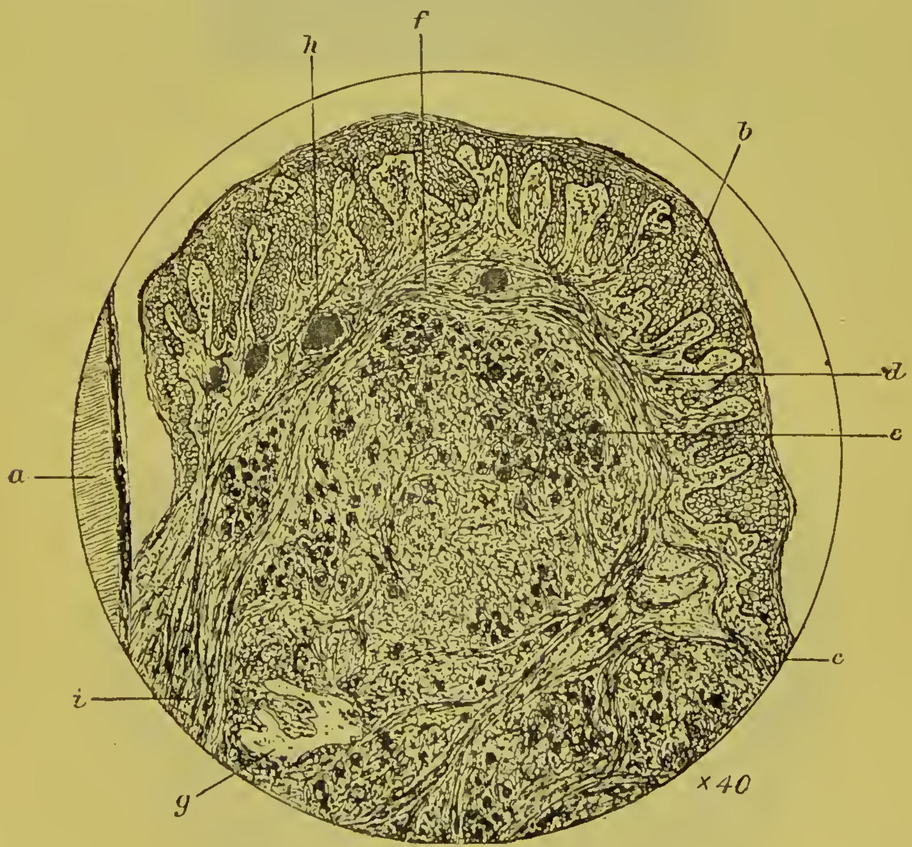


FIG. 530.—Longitudinal section of a tumour similar in external appearance to figs. 528 and 529. (*a*) Dentine and cementum; (*b*) stratified epithelium; (*c*) basement membrane; (*d*) submucous tissue; (*e*) masses of giant cells; (*f*) fibrous septa; (*g*) nodule of bone; (*h*) spaces filled with colloid material; (*i*) attachment of tumour to cementum.

Fig. 531.—Copied from the *Trans. Odonto. Soc.*

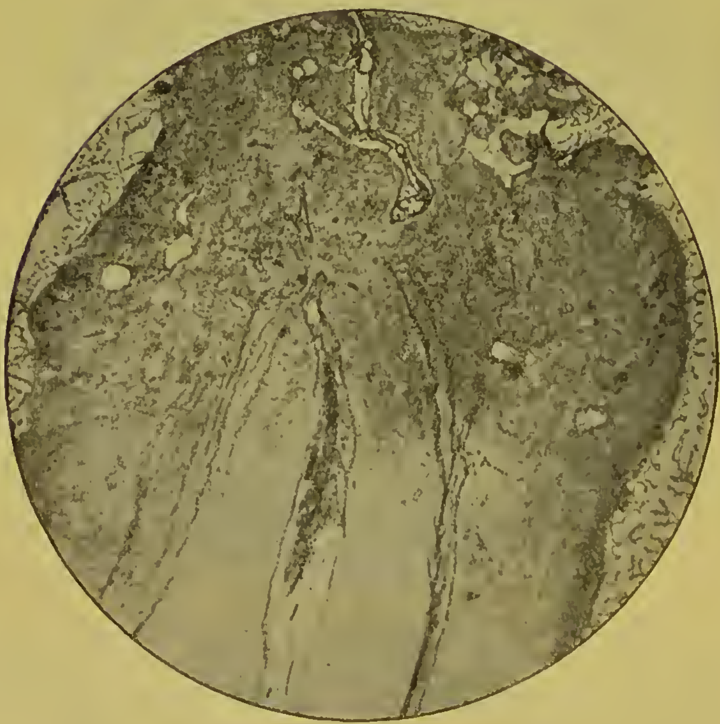


Fig. 532.—Copied from the *Trans. Odonto. Soc.*

to and spring from the periodontal membrane, and come away when the tooth is removed. They are of slow growth and are more common in the mandible than in the maxilla. A section of a growth of this character is shown in fig. 530. It was attached to the anterior aspect of the root of a first mandibular molar half way down.

(D) ANCHYLOSIS OF THE TEETH TO THE JAWS.

Anchylosis of the teeth to the jaws may occur, but it is rare. The pathological changes which produce this condition between the teeth and the alveolar process are similar to those occurring in joints in other parts of the body. An interesting case came under the notice of Mr. E. Lloyd-Williams. The patient was a man suffering from suppuration, and a maxillary molar and premolar were removed with large masses of bone attached to them. Examination of the specimens showed them to be examples of anchylosis of the teeth to the bone. The molar is shown in fig. 531, while a decalcified section of the premolar is seen in fig. 532. It will be noticed that the tooth and bone are intimately connected. An interesting case of anchylosis to the jaw of a retained deciduous molar in a man, 40 years of age, is described by Dr. Amoedo, in the *Cosmos*, 1895.

CHAPTER XIII.

Diseases of the Gums and Adjacent Mucous Membrane.

(A) HYPERTROPHY OF THE GUMS.

Cases of hypertrophy of the gums are not common. There are at least three clinical varieties. **In one, the hypertrophied gums resemble the normal gum** in density and colour. The figs. 533 to **536** delineate the mouths of two brothers, aged respectively 7 and 9 years, which came under observation at the Dental Hospital of London in 1892.

Fig. 533.—F. S., aged 9 (maxilla).

A case of this variety is given by Heath.[1] The patient was $4\frac{1}{2}$ years of age. The swelling of the gums had begun with the eruption of the second deciduous molars, and from them had spread until the condition shown in fig. 537 had developed.

[1] "Injuries and Diseases of the Jaw." Fourth edition. P. 229.

A microscopical examination, made by Mr. C. S. Tomes, of this case, showed that "the growth closely resembled that of the small polypi which are sometimes found occupying the cavity of carious teeth; it was a true hypertrophy of the gum, and chiefly

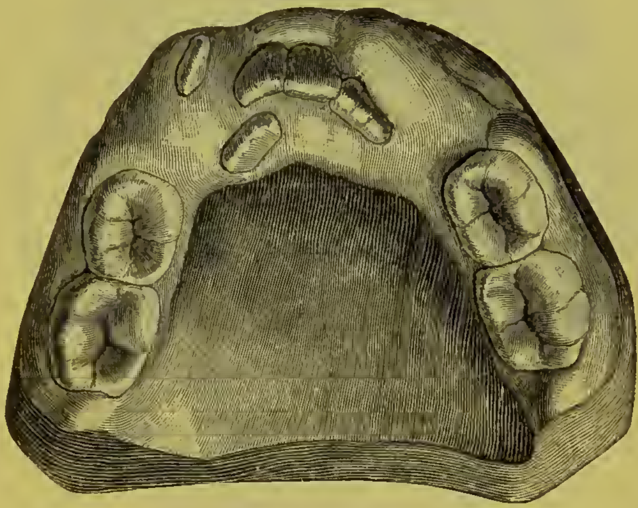


Fig. 534.—F. S., aged 9 (mandible).

Fig. 535.—T. S., aged 7 (maxilla).

of the fibrous portion. It sprang from the periosteum round the neck of the tooth just within the margin of the alveoli. From this point a dense stroma of interlacing fibres, covered by a thin mucous and epithelial layer."

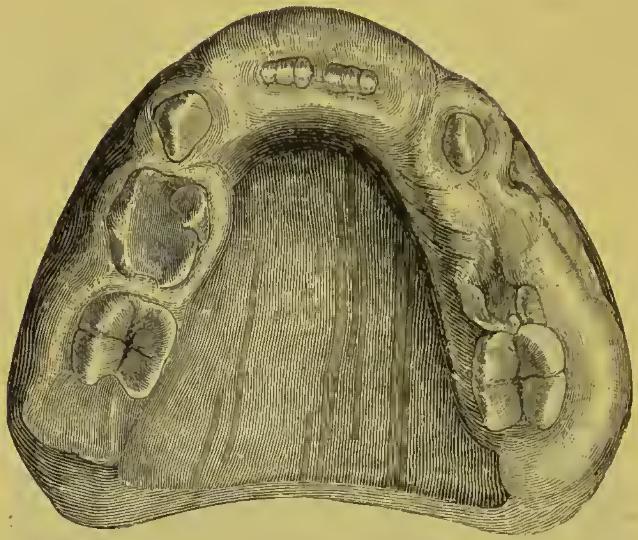


FIG. 536.—T. S., aged 7 (mandible).

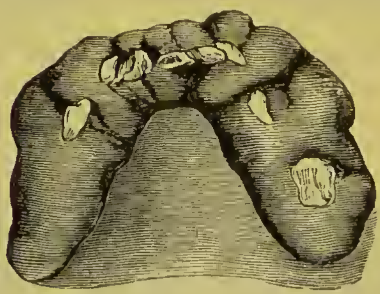


FIG. 537.

FIG. 538.—From the *Trans. Odonto. Soc.*

In a second variety the gum, instead of showing a smooth surface, presents numerous hypertrophied papillæ. This is shown in fig. 538. This patient, aged 43, was under the care of Mr. Montague Hopson. He subsequently developed a sarcoma in connection with the orbital plate of the maxilla. Two of his children also show slight hypertrophy of the gums.

FIG. 539.

In a third variety the gums are often enormously increased in size, nodulated, and of a dark purple colour, and bleed readily on the slightest touch. This is the most distressing form of hypertrophied gums. A case of this character is recorded by Mr. Christopher Heath (*Lancet*, 1897). Four years previous to being seen by Mr. Heath, the patient had consulted Mr. Hulke, who cut away the hypertrophied gums of both jaws with much relief to the patient. Three months afterwards the patient noticed that the growth had recommenced, and although it had made steady progress for three years, he had sought no further advice.

On admission to University College Hospital, the external deformity was well marked, and on opening the mouth the gums of both jaws were seen to be enormously hypertrophied, and most of the teeth to be loosened and displaced. The palate looked at first like a cleft palate, but this was due to the hypertrophied gum on each side covering the palate nearly to the median line (fig. 539).

A microscopical examination of this hypertrophied tissue showed that the mucous membrane covering the growth was healthy, the bulk of it being composed of delicate bundles of wavy fibrous tissue, which interlaced. Between the bundles were numerous cells, in some places forming large clusters. Numerous vessels were scattered through the growth.

The appearance of hypertrophy of the gums in children is often coincident with the eruption of teeth. In a case quoted by Mr. Erichsen the affection showed itself at seven months, during the eruption of the incisors.

Abnormal conditions of the gums are at times correlated with abnormalities of other tissues. In Mr. Erichsen's case the patient subsequently developed abnormalities of the "skin, subcutaneous connective tissue, periosteum and the ends of the fingers and the toes."

In the well-known case of Julia Pastrana, hypertrophy of the alveolar process and over-lying soft tissues was accompanied by excessive development of the hair. A similar condition existed in a case mentioned by Parreidt,[1] in an Indian girl, Kras, seven years of age. The hypertrophied gums were accompanied by a well-developed growth of hair on the body.

Treatment.—Microscopical sections demonstrate that the hypertrophied gum springs from the alveolar margin. In treatment, the affected alveolus must therefore be removed with the excess of gum, the trouble being liable to recur if the gum only is removed.

(B) INFLAMMATION OF THE GUMS AND ADJACENT MUCOUS MEMBRANE.

Inflammation of the mucous tissue of the mouth is called stomatitis; when affecting the gums it is termed gingivitis. Some little confusion has arisen from the use of these terms. It is therefore proposed to limit the term "gingivitis" to inflammations which arise and usually remain limited to the gums, and to adopt the term "stomatitis" for inflammations in which the gums, buccal mucous membrane and other mucous surfaces of the mouth may be involved.

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[1] *Deutsche Monatsschrift für Zahnheilkunde*, 1886. Jahrgang iv., Heft 2.

(1) GINGIVITIS.

This condition may be general or limited to the gum margin, "marginal gingivitis."

Anatomy of the gingival margin.—If a section through the gingival margin be examined it will be noticed that the gum (muco-periosteum) blends with the periodontal membrane, the union being marked by an extra density of fibrous tissue to which the name of **the dental ligament** has been given. The gum is attached in such a way as to leave a free margin round the tooth and form, as it were, a pocket. Tucked away in this pocket is a mass of "round or polygonal gland-like epithelium." This mass of cells, according to Black, although suggesting the formation of a gland, fails to assume the glandular structure. This tissue is known as the **gingival organ.** It emits a profusion of small round cells, which may

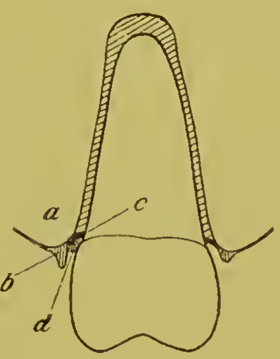

FIG. 540.—(*a*) Alveolar process; (*b*) free margin of gum; (*c*) dental ligament (*d*) gingival organ.

accumulate in considerable numbers under the free margin of the gums, and with micro-organisms form the cheesy-like material that can so often be squeezed from under the free margin of the gum.

(a) **Marginal gingivitis** is a common affection, and leads, if not treated, to chronic periodontitis.

Pathology.—The gingival organ, in common with other glandular structures, seems to possess the function of selecting and eliminating from the blood certain poisons, as evinced in mercurial gingivitis. The elimination of the poisons or toxins produces hyperæmia or inflammation. As a result of hyperæmia or chronic inflammation a dark-coloured calculus forms under the free margin of the gums

(fig. 541). The exact manner in which this calculus is formed is not clear. It may be a product solely of the inflammatory condition of the gingival tissues, or a union between the calcium salts of the saliva and the inflammatory exudation. The calculus when formed acts as a local irritant and increases the morbid condition. In certain conditions the calculus does not form.

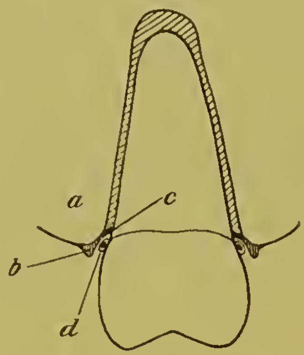

FIG. 541.—(*a*) Alveolar process; (*b*) free margin of gum; (*c*) dental ligament; (*d*) calculus.

Varieties.—The **inflammation** is **usually catarrhal** in character. It **may become purulent,** while in patients of "strumous" diathesis there is a tendency to hypertrophy, so that large tags of tissue are formed between the interspaces of the teeth, the gum encroaching upon the surface of the teeth, causing a large portion of them to be hidden. This form is usually designated "**chronic hypertrophic marginal gingivitis.**" The so-called "polypus of the gum" is a localised "chronic hypertrophic gingivitis."

Causes.—(i.) *Local.*—Mechanical irritants, such as the accumulation of calculus and food *débris* at the necks of the teeth. Overhanging edges of fillings and badly adjusted crowns; these act mainly by favouring lodgment of food. The injudicious use of clamps, ligatures, &c., and chemical irritants, for example, escape of escharotic drugs on the gums.

(ii.) *General.*—The prolonged administration of mercury, lead and iodides. Marginal gingivitis is a constant accompaniment of general inflammatory disease and chronic nutritional affections, such as gout, diabetes, nephritis.

Signs and symptoms.—The free margins of the gums are red and painful, and bleed freely with the slightest touch. Slight

pressure will cause a thick creamy discharge to exude around the necks of the teeth.

Treatment.—**If the cause is local** the source of irritation should be removed, the pockets around the teeth syringed with hydrogen peroxide and an astringent mouth-wash prescribed. In marked cases the application of powdered tannic acid to the gums twice a day should be ordered. Painting the gums with tincture of iodine and spirits of camphor in equal parts will be found especially useful in cases where there is pain.

When the inflammation is of the hypertrophic variety, it is advisable, in addition to the above treatment, to cut off with a small pair of curved scissors the little tags of gum which are present in the interstices of the teeth, and freely scarify the other portion of the gum. **If due to a general cause** this must be treated, and local measures carried out as described above.

Lead poisoning in relation to the gum margins.—In chronic lead poisoning a blue or slate-coloured line often appears on the gums. The manner in which the line is formed is not quite clear. It is supposed that the lead brought by the blood to the gingival margin is converted into a sulphide. The line is more frequently seen on the lower gums than on the upper, and in the incisor region more than in the molar. In addition to the blue line, lead poisoning usually presents other symptoms, such as colic and wrist drop, the latter being due to paralysis of the extensor muscles of the wrist. In rare cases the blue line is present, but no other symptoms; in such cases great care must be taken to eliminate all other possible causes.

The blue line must be diagnosed from (*a*) a delicate line of blue at the margin of the gums and teeth, but not involving the gums, which occurs in persons exposed to white lead dust for a few hours. This line is merely lead sulphide deposited upon the gums and disappears on rinsing the mouth.

(*b*) A deposit under the margin of the gums, which is found in persons who clean their teeth with charcoal.

(*c*) A deposit similar to *b*, occurring in miners and others exposed to carbon dust.

(*d*) The line caused by copper and bismuth poisoning, and

(*e*) A line caused by a thin layer of dark tartar under the free margin of the gum.

It must be noted that the blue line does not appear if the teeth

are missing, and that it is most prominent when a source of irritation, as, for instance, "tartar," exists around the necks of the teeth.

Treatment consists in removing the patients from the unhealthy surroundings, when the line will generally disappear in three or four weeks, although in severe cases the line may persist for a much longer period.

(b) **General chronic gingivitis** is usually the result of local irritation. It is seen in patients wearing artificial dentures, and is often due to want of cleanliness. The gums are slightly swollen and are red, congested and painful. A temporary relinquishment of the denture and the use of astringent mouth-washes is sufficient to effect a cure. Any general condition will need treatment.

Artificial dentures in certain subjects, more especially those of a gouty or rheumatic diathesis, produce a peculiar tenderness of the gums, accompanied by an itching sensation, the patients stating that they can only get relief by removal of the dentures. Local applications are of little value, and the removal of the denture, except, of course, at meals, seems to be the only means of obtaining relief.

A form of **chronic gingivitis atrophic in character** is described by Mr. Tomes.[1]

The gums "assume a very red, smooth, and polished surface, and mottled aspect. At the same time the disease may extend over the surface of the hard palate. The malady is attended with acute intermittent pain, which may be confined to one side of the mouth or even to half of the upper jaw ; it very commonly comes on in the evening and keeps the patient awake half the night." The trouble seems to occur in females about the period of "menopause."

A rare form of chronic inflammation of the gums, under the name of "**gingivitis nudata**," has been described by Arkövy.[2] The disease usually has its seat in the roof of the mouth, spreading until it involves the interdental papillæ, or it may be limited to the latter. It appears at all stages of life and may continue for one or two years. It is difficult to determine with the naked eye the junction of the affected with the non-affected part, as the edges are not pronounced and the colour of the gums unaltered. *The*

[1] "Dental Surgery," Third Edition, p. 726.

[2] *Cosmos*, October, 1893.

pathology of the condition is an entire absence of the epithelial covering of the sub-mucous tissue, leaving the papillæ exposed.

The etiology is obscure; occasionally it may be traced to scalding. Dentures with rough surfaces, or which do not fit accurately, may contribute to the production of the disease. The symptoms are a feeling of "continual burning with sensitiveness of touch, especially during meal times."

Treatment should aim at restoring a layer of epithelium over the denuded sub-mucous tissue. All irritants, whether in the form of foods or otherwise, should be avoided. The foods taken must be of a mucilaginous and slippery character, and all medicaments must be administered in a similar condition.

(c) **Polypus of the gum.**—Polypus of the gum is the name given to local hypertrophies of that tissue caused by irritation.

Causes.—This condition is generally found in connection with the ragged edge of a cavity or root, or may be brought about by the presence of calculus, or even irritation from a clasp or some other portion of an artificial denture.

Appearances.—In character and microscopical appearance a polypus resembles the gum tissue. The growth really starts as a simply hypertrophy of the gum; this increases and becomes pedunculated, and if the cause is not removed, may become so enlarged as to simulate a fibrous tumour.

A polypus of the gum may, as it grows, encroach upon the cavity and eventually completely fill it. Should the hypertrophied tissue come in contact with the opposing teeth, ulceration will ensue and give rise to considerable pain.

Diagnosis.—When the polypus occupies the cavity, care must be taken to diagnose it from a polypus of the pulp. The diagnosis is not difficult, as in one case the pedicle of the growth will be in connection with the pulp chamber, while in the other it can be traced to the gum between the teeth. The polypus of the pulp is not painful to the touch, whereas polypus of the gum is extremely painful to pressure.

The treatment consists in removing the source of irritation, but it is in addition generally advisable to snip off the growth, or if the growth is in connection with a cavity, it is better to remove the growth with some potassa cum calce, or with the actual or electrical cautery. The cervical margin of the cavity must be carefully

trimmed and care taken that the filling does not overlap at this point and so leave a source of irritation.

(2) STOMATITIS.

(a) **Catarrhal.**—This form is generally associated with inflammation of the throat or nose, and probably arises from the same cause as catarrh of those parts. It is frequently seen in the course of the exanthematous fevers and gastro-intestinal disturbances. The excessive use of tobacco, or too hot or too highly seasoned foods may be cited as causes.

Signs and symptoms.—The serum from the congested mucous membrane filters into the sub-epithelial space. There is an increased production of surface-epithelium and also of mucus. This mucus continues and with the serum forms the peculiar sticky discharge seen in these cases. In more severe cases the epithelium may be detached in large masses, the sub-mucous tissue becomes greatly infiltrated with leucocytes and the whole mucosa swollen, giving rise to a purulent or muco-purulent condition. The margins of the gums become acutely inflamed and painful to the slightest touch. In the early stages the gums are dry, but this is soon followed by an excessive secretion. The portion of gum attached to the margin of the alveolus is pale, while the reflection of gum from this point on to the cheek will show the vessels to be congested. The gums appear whitish and mottled, and pus is generally seen welling up from the sulci around the teeth.

The mottled appearance of the gums is due to the fact that in inflammation the epithelium proliferates and appears whitish; but through the friction which occurs between the gums and the cheeks the epithelium covering the papillæ of the gum is rubbed off, and leaves reddish patches here and there. The breath is fetid, the patient has a sensation of heat and pain, and the taste is impaired. The tongue is furred, there is loss of appetite, derangement of the bowels, and a feeling of malaise.

(b) **Mercurial stomatitis.**—Prolonged use of mercury is likely to lead to gingivitis, which rapidly spreads to contiguous parts, such as the salivary glands, in which case it causes ptyalism. The early symptoms are soreness and discomfort in the mouth, accompanied by a metallic taste, and the breath is fetid. The gums become

inflamed, and present a deeply congested appearance at the free edge, while the portion attached to the margin of the alveolus remains whitish, and the portion beneath presents the whitish mottled appearance referred to above. The teeth become loose, sloughing and ulceration occur near the margin of the gum, the slough separates, and the teeth fall out. The inflammation spreads rapidly to the cheeks, tongue, floor of the mouth, and to the salivary glands, leading to a profuse flow of saliva. There is much pain in swallowing, speaking and on moving the jaws. In severe cases, if not quickly treated, extensive sloughing and necrosis may supervene.

Treatment. Local.—In mild cases the use of an antiseptic mouth-wash is sufficient. In severe cases local depletion will be found advantageous.

General.—The administration of the drug must be stopped and the bowels made to act freely by means of saline purgatives. A plentiful use of alkaline mineral water should be enjoined. The diet should be in a liquid form, and if there is much pain, opium in the form of pulv. opii. co. may be given at night. The general anæmic and debilitated condition which follows severe "ptyalism" requires a supporting form of treatment.

(c) **Ulcerative stomatitis.**— This condition is most frequently met with in children. It may prevail in an epidemic form in institutions where unsanitary conditions exist. Want of cleanliness favours the development of the disease.

The inflammation commences at the free margin of the gums, and is said to be more frequent in the maxilla. In the early stages the gums are swollen and congested, the congested veins leading to the part being distinctly visible. The ulceration, commencing at the free margin, gradually spreads, denuding in its course the alveolus, and leading to necrosis of the teeth. The adjacent mucous surface of the cheek generally becomes attacked from contact, and if the case is left alone the ulceration may extend, leading to extensive necrosis, sloughing, and ultimately death of the patient. In well developed cases, an ulcer with sharp irregular edges is seen, the margin displaying a bluish ring, the ulcer being covered with a greyish or yellowish slough, and the neighbouring lymphatic glands being enlarged.

Of the **bacteriology of ulcerative gingivitis** little is known. Guezzetti is of the opinion, after a careful examination of three

cases, that the condition is closely allied to "noma," gangrenous gingivitis, or stomatitis, as he found a spirilla and a bacillus, the latter having the closest resemblance to the bacillus found in "noma."

In the opinion of some, stomatitis, when occurring in epidemic form, is identical with "foot and mouth" disease of animals. Stoerk[1] states that epidemic gingivitis is frequently contemporary with "foot and mouth" disease, and is particularly noticeable in children brought up on cows' milk, the disease frequently not yielding until the milk diet is stopped. These facts point to a direct infection.

Signs and symptoms.—In the early stages there is little pain, and the disease may be far advanced before it is discovered by the parents, and then the odour of the breath is the first symptom noticed. Constitutional symptoms are marked in severe cases, and death sometimes results.

Treatment. Treatment consists in administering internally chlorate of potash, a drug which seems to be a specific for this disease. Children should be given five to ten grains according to age, adults fifteen to twenty grains. It is well to give at the same time some iron or such like tonic in the following form :—

℞.	Liquoris ferri perchloridi	♏ij.
	Potassæ chloratis	gr. v.—x.
	Aquam aurantii ad	ʒj.
Misce.	Mitte ℥ij.	

(One teaspoonful to be taken three times a day after meals.)

A mild purgative should be given, and an endeavour made to improve the surroundings of the patient should these be at fault. Plenty of exercise in the fresh air should be recommended.

Locally, the ulcer should be painted with a strong solution of nitrate of silver, the mouth being kept clean by wiping the surfaces of the ulcer with a piece of lint. Should the cheek be involved as well as the gums, a strip of lint moistened with carbolised oil should be placed between the two surfaces. A gargle of chlorate of potash should be prescribed,[2] and its frequent use recommended.

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[1] *Wiener Klin. Wochenschr.*, 1897, p. 77.

[2]

℞.	Potassæ chloratis	ʒj.
	Acidi hydrochlor. dil.	ʒss.
	Aquam ad	Oj.

Misce. To be used as a gargle.

Under this treatment most cases speedily improve. When the teeth have become very loose they should be removed, as they only act as a source of irritation.

A curious form of ulcerative stomatitis intimately connected with menstruation is recorded by Davis[1] under the name of **cyclical stomatitis.** The patient, who was a married woman aged 35, had had four children. "Several times before the birth of the last child attacks of stomatitis coincided with menstruation. For three years after this she suffered from severe ulcerative stomatitis, involving the tongue and the whole of the buccal mucous membrane. The first sign of the molimen was soreness of the mouth, appearing five days before the menstrual flow. The attack was at its height at the end of menstruation, at which time the mouth was full of small dirty ulcers. During the stomatitis no solid food could be taken, and liquids only with caution. All medical treatment had failed, and as the patient was losing ground the tubes were removed. Both ovaries contained cysts about the size of a duck's egg, and the right Fallopian tube contained a mass of blood clot which was not a tubal gestation. The patient completely recovered. As to the explanation of the cyclical character of the stomatitis, the author suggests that it may have been a feeble attempt at vicarious menstruation."

Dr. J. S. Marshall, of Chicago, has drawn attention to **a form of ulcerative stomatitis which sometimes follows injuries to the gums** from removal of teeth, vigorous use of the tooth brush, &c.

"The clinical characteristics are the formation of ulcers at some point of injury, which at first appear in nowise different from the ordinary form of a localised ulcerative stomatitis, but which, after the lapse of twenty-four to forty-eight hours, begin to spread rapidly along the margins of the gingivæ in all directions, involving both jaws, and sometimes extending to the hard palate and the floor of the mouth. The margins of the gums assume a general ulcerative condition, accompanied by swelling, redness and considerable congestion of the parts, which bleed easily. Later they become covered with a dirty white or yellowish-white pellicle or membrane —somewhat resembling the thrush film—which sloughs off after a day or two, destroying the festoons and leaving a ragged surface.

[1] *Medical Times*, May, 1898.

The denuded surface is very red and covered with coarse granulations, which bleed upon the slightest provocation. The gums are loosened from the necks of the teeth and the borders of the alveolar processes are exposed. Pus mixed with blood exudes from the inflamed tissue about the necks of the teeth. The breath and excretions are very fœtid, and salivation is profuse. In these respects the symptoms resemble mercurial ptyalism. The ulcerated surfaces are exceedingly sensitive and motions of the tongue and lips on this account are very painful. Food is taken with difficulty. Accompanying the local manifestations there is a general febrile condition, temperature ranging from 100° to 101° F., thirst, loss of appetite and general malaise, sleeplessness and irritability of temper."

The treatment recommended is thorough irrigation of the teeth and gums with antiseptics followed by the application to the ulcerated parts of an escharotic, such as a 10 per cent. solution zinc ointment.

(d) **Gangrenous stomatitis: noma: cancrum oris.**—This very serious disease is a rapidly-spreading gangrenous inflammation, which usually attacks the cheeks, and occurs in children generally from two to six years old. It is more common in girls than in boys. It is frequently seen in those just recovering from one of the exanthematous fevers, and is stated by Erichsen to be commoner after measles. Unhygienic surroundings and weakening of the system by long-continued administration of mercury also act as predisposing causes. The disease may start either in the substance of the cheek or in the mucous membrane, the latter being the commoner situation. The cheek becomes hard, brawny, and very swollen, a dark red colour showing in the centre, the surrounding parts being œdematous. At this stage, if the mouth be examined, an ulcer will be seen on the mucous surface of the cheek corresponding to the dark spot on the cheek. The ulceration, or rather sloughing, leads to perforation of the cheek, and if the disease still pursues its course the soft parts rapidly become gangrenous. The child becomes exhausted, delirious, and eventually dies of either exhaustion, blood poisoning, or some septic affection of the lungs.

The facts that the whole cheek becomes gangrenous, and that the disease is not amenable to the action of chlorate of potash, help to distinguish it from ulcerative stomatitis, but most authors think that the difference between cancrum oris and ulcerative stomatitis is only one of degree. The disease is said to be caused by thrombosis of

the capillaries, induced by the presence of a specific micro-organism, and is similar to the gangrenous inflammation known as noma, which occurs upon the female genitals.

The *prognosis* of cancrum oris is bad. The *treatment* consists in carefully drying the soft parts, removing all gangrenous portions, and cauterising the remaining surface with nitric acid, or the actual cautery. The general treatment will consist in supporting the patient's strength with a plentiful supply of beef tea and other nutritious remedies. It has been suggested that free excision of the gangrenous surfaces would be an effective treatment, and in cases recorded it has proved beneficial. Corrosive sublimate locally applied has been used; it has proved successful in three cases recorded by Kingsford in the *Lancet* of May 4, 1889. Disinfectant mouth washes must be prescribed, and the raw surfaces carefully dressed with antiseptics. The disease may spread until the whole side of the face disappears, the cavity extending from the nose to the ear, and from the lips to the upper eyelid.

A condition apparently allied to gangrenous stomatitis is described by Smithson under the name of "**phlegmonous ulceration of the mouth.**" The gums were acutely inflamed and sloughing. The breath offensive and the tongue swollen. The condition was attended by marked symptoms of fever, high temperature, rapid pulse, &c. The inflammation spread and involved the soft palate and tongue, but was unattended by periostitis. Towards the end of the disease antistreptococcic serum was tried, with benefit at first, but eventually the patient relapsed and died. The condition seems in some respects similar to "phlegmonous erysipelas."

(e) **Follicular stomatitis.**—This inflammation is similar to an ordinary herpetic eruption. A cluster of vesicles first appears which, on breaking down coalesce and form a small circular and well-defined ulcer. This ulcer is surrounded by a zone of redness, and is extremely painful. The ulcers are said to occur more frequently near the frænum of the lip, on the under surface of the tongue, and in the sulcus between the gums and the lip. The little round punched-out ulcers met with in the cheeks are probably a variety of this form. Follicular stomatitis occurs in adults less frequently than in children. It is often associated with some gastro-intestinal disturbance.

The *treatment* consists in the application of an astringent solution, and in intractable cases the ulcers may be touched with a

crystal of sulphate of copper or nitrate of silver. The general condition of the patient must also be treated.

(f) **Parasitic stomatitis.**

(i.) **Due to saccharomyces albicans—Thrush.**—Thrush is a parasitic inflammation of the mucous membrane of the mouth, dependent upon a fungus, the saccharomyces albicans. It is common in infants, but may occur in adults, and in the latter is generally associated either with some of the acute specific fevers, or with chronic wasting diseases, such as phthisis. In the latter it is generally an indication of a fatal termination. The fungus develops in the upper layers of the mucosa, the filaments forming a dense net-work among the epithelial cells. In this manner the mucous membrane becomes covered with numerous white spots, which are firmly adherent, and when removed a deep red colour is revealed. These patches appear mostly near the angles of the mouth and on the tongue, but may occur elsewhere in the oral cavity, the affection spreading at times to the pharynx and œsophagus. The spots are about the size of a pin's head, are circular, gradually coalesce and form larger patches, giving rise to the appearance of a false membrane with a slightly yellowish aspect. The membranes so formed come away of their own accord leaving a reddish surface beneath. The patches are found to consist of epithelium and fat, together with sporules of the oidium albicans, the vegetable parasite which causes the disease.

When thrush occurs in children they are generally found out of health, the bowels relaxed, the evacuations green and sour. The motions are generally acrid, and irritate the margins of the anus, giving rise to an erythematous blush over the buttock, the appearence of the edges of the anus being similar to that seen in the mouth. Sucking and deglutition are impaired by the condition of the mouth, and the child will usually be in a state of drowsiness and torpor. Many cases of thrush in infants are distinctly traceable to the use of dirty feeding-bottles.

The treatment of the thrush may be divided into local and general. The *local* consists in carefully wiping the mouth with soft lint after each meal, care being taken to burn the lint after use. The exposed surfaces thus left are touched with a solution of three drachms of borax to the ounce of water. In severer cases it will be advisable to use nitrate of silver, five grains to the ounce, or dilute carbolic acid in glycerine. It is needless to say that attention

should be given to the condition of the feeding-bottle. The *general* treatment will consist in careful attention to the diet, with the administration of a mild aperient.

(ii.) **Due to the aspergillus nigrescens.**—An inflammatory condition due to the presence of the aspergillus nigrescens has been reported.[1]

The following is a brief account of the case: "A small ulcer first appeared on the middle line of the roof of the mouth, about half way between the incisors and the soft palate. The patch increased slowly in size, and others formed in the neighbourhood, the condition appearing like a lumpy patch extending from just behind the incisors to within one-fourth of an inch of the soft palate. Cup-shaped elevations on the soft palate appeared on either side of the middle line. A firmly attached membrane, giving rise to hæmorrhage when forcibly removed, covered the areas. The colour of the recent deposit suggested the sulphur-coloured scutala of favus; where it had remained undisturbed it was darker. With low power the growth was recognised under the microscope as a fungus differing from the achorion. The mycelium network was composed of delicate fibres, bearing perpendicular fructifying hyphæ. Scattered over the field were a number of fruit receptacles and a few spores. The manner of fructifying showed that the fungus did not belong to the oidium, but to the ascomycetous genus. Cultures showed it to be aspergillus nigrescens which had caused the inflammation. Upon applying 25 per cent. ethereal solution of pyrozone, improvement was immediately noticed. The pseudo-membrane disappeared and new patches ceased forming. After seven weeks' treatment the patient was well."

"The spores were supposed to have been implanted in the mouth through the medium of cheese, strong and mouldy varieties of which the patient was very fond of eating."

(g) **Aphthous stomatitis.**—This form but rarely occurs in adults. It is characterised by the formation of fibrinous deposits on and under the epithelium, and is considered by some authors to be contagious. It is frequently met with in rachitic and weakly children and is most common during the periods of dentition. In adults it occurs in those debilitated by illness, or may be associated with general inflammatory conditions. In women

[1] *Medical Record*, October, 1896 ("The Dental Digest," p. 641, 1896).

it occurs during menstruation, pregnancy, and during the puerperal period.

Signs and symptoms.—Small yellowish-white patches, slightly elevated and exceedingly sensitive, are present on the mucous membrane. The patches are surrounded by a zone of inflammation. They have a tendency to spread and coalesce, forming large patches. When not associated with any active general disease constitutional symptoms may be present, namely, slight elevation of temperature, thirst and loss of appetite.

Treatment.—Locally, a mouth-wash of chlorate of potash should be used, and the mouth thoroughly cleansed after each meal. If the aphthæ persist, they may be treated with nitrate of silver. The constitutional condition also requires attention.

(h) **Membranous stomatitis.**—In this form the mucous membrane becomes covered with a whitish membrane which is easily detachable and leaves no ulcerated surface behind it. The condition is accompanied by salivation; it is a rare condition. In one case reported by A. J. Hall,[1] the membrane when examined showed staphylococcus pyogenes, aureus and albus. In another example recorded by Mr. Stanley Colyer, the condition was at first mistaken for diphtheria. The membrane, which was confined entirely to the left side of the mouth, covered the hinder portion of the left border of the tongue, the gum around the mandibular molar teeth, and the tonsil. Bacteriological examination failed to disclose the presence of Klebs-Loeffler's bacillus. There was an abscess in connection with one of the molar teeth. On removal of this tooth the membrane began to clear up and soon disappeared.

(i) **Chronic neurotic stomatitis.**—This condition appears usually in patients suffering from mental worry. It is an uncommon condition. Knowsley Sibley[2] considers that it is not of the nature of pemphigus, as sometimes described, but is a separate affection.

"It generally commences as a crack or streak, or from the beginning as a small superficial bright red ulcer. Occasionally in the tongue it begins in an inflammatory localised thickening just beneath the mucous membrane, which rapidly breaks down and forms an ulcer, usually with a slough in the centre and considerable inflammatory redness around. It sometimes happens that the

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[1] *British Med. Journ.*, July 16, 1888, p. 153.
[2] *Ibid.*, April 1, 1899, p. 900.

ulceration is preceded for a day or two by a heaping up of the epithelium, often forming a pale, gelatinous-looking ridge fitting in the spaces between the teeth. At other times the ulcers are preceded by small gelatinous-looking bodies about the size of millet seeds, and occasionally by small vesicles ; accompanying the ulcers is usually a considerable desquamating catarrh of the surface of the tongue. There is usually a good deal of burning sensation and great distress, accompanied by profuse salivation, and if the ulcer is very indolent, with œdema of the parts around. If the lesion is situated in the mucous membrane of the lips, these may become so swollen as to hardly permit of the mouth being opened and the tongue protruded. The ulcers are produced by a distinct trophoneurosis, and they are quite different from the common catarrhal or dyspeptic ulcer."

In one case recorded by Sibley the ulcers had appeared intermittently for twenty-three years.

Treatment.—Complete rest from worries is needful. Locally, the healing of the ulcers may be expedited by the application of tincture of iodine. The pain and distress may be mitigated by the use of cocaine, or in severe cases opium.

(C) PEMPHIGUS.

The eruption of pemphigus may occur in the mouth, and one rare form, **pemphigus vegetans**, may remain localised to the mouth and adjacent cavities. The following case[1] will illustrate this condition.

The patient was a man aged 72, who complained of soreness in his mouth and inability to take solid food. On the roof of the mouth and on the epiglottis were patches of false membrane of considerable thickness, which, when removed, left a raw, bleeding surface. Some decayed teeth were extracted and antiseptics used, but blebs formed on the roof of the mouth, the soft palate, the cheeks, under the tongue, and on the posterior wall of the pharynx. Bacteriological examination of the membranes gave negative results. There was neither fœtor nor salivation. Whenever the patient attempted to masticate solid food a fresh crop of blebs appeared.

[1] Dr. Lewis Maller, *New York Med. Journal*, July 3, 1898.

(D) PURPURA.

In the severe form of purpura known as "purpura hæmorrhagica" the gums and mucous membranes may be the seat of the hæmorrhage. A very similar condition to this is occasionally seen in patients the subjects of hæmophilia, spontaneous hæmorrhage occurring at the margin of the gums.

The treatment of purpura belongs to the domain of general medicine. The hæmorrhage from the gums can be treated by the use of astringents such as tannic acid, the application being combined with a certain amount of pressure.

(E) SCURVY.

The effect of scurvy on the gums is that they become dark, turgid, spongy, and swollen, so as to hide a considerable portion of the surfaces of the teeth. At first the gums bleed readily; this is followed later on by a constant oozing. Ulceration and sloughing of the edges of the gum take place, leading to loosening and loss of the teeth and necrosis of portions of the jaws. In scurvy the mucous membranes are anæmic, and there will be a strong contrast between the reddened gum and the pale mucous membrane covering the lips. The local symptoms are always associated with marked general symptoms indicative of the disease.

The treatment of scurvy cannot be dealt with here. Suffice it to say that the mouth must be kept quite clean and aseptic by the constant use of antiseptic lotions.

(F) PERFORATING ULCERS OF THE MOUTH,

due to trophic changes, are occasionally seen in patients the subjects of *tabes dorsalis*.

(G) TUMOURS OF THE GUMS.

(1) VASCULAR TUMOURS.

These growths, which occasionally occur upon the gums, may simulate a capillary nævus, in which case they are composed of dilated capillaries; a venous nævus, where they are composed of irregular spaces containing venous blood; or an arterial nævus, the irregular spaces being filled with arterial blood.

These growths usually present a smooth surface. They vary in colour, being bright red in arterial and purple in venous nævi; on pressure being applied they become pale, rapidly returning to their original condition after removal of the pressure. They are more common in the incisor region, though they may occur in that of the molars. Starting as a little red spot, they gradually spread between the teeth and extend principally along the margin of the gum, both in front and behind the teeth. These growths bleed

FIG. 542.—Papilloma of the gum (Heath).

readily when touched with the tooth-brush, and in one patient under notice the hæmorrhage was severe. In the case of distinct venous nævi the tumour may attain to a large size, and involve the mucous membrane of the gum, cheek and lip. The **treatment** of these cases belongs to the domain of surgery, and the patient should be at once referred to a surgeon. In a case under the care of Mr. Shield of an aneurism by anastomosis occurring in the palate, resection of a portion of the jaw was carried out on account of the repeated and serious hæmorrhages.

(2) FIBROMA.

This tumour has usually been classified as a tumour of the gum. In reality it must be regarded as a tumour of the alveolar portion of the jaws. Fibromata generally spring from the periosteum covering the septum between two contiguous teeth. They are of slow growth, and by their pressure separate the adjacent teeth, but

when arising near a root they tend, by their growth, to completely cover it. In character they resemble the normal gum, and on examination will generally be found pedunculated. Some of these growths seem to spring from the anterior surface of the alveolus, and when this is the case the situation is usually the region of the maxillary canine. If the tumour grows so that it comes in contact with the opposing teeth ulceration may be set up, causing great pain. Again, if left untreated, it may assume large dimensions so as to protrude from the mouth. A remarkable case of this character occurred in the practice of Liston, and is referred to in Heath's work on "Injuries and Diseases of the Jaw." In structure fibromata are composed of bundles of fibrous tissue with a scattering of elastic fibres. Most examples contain a few myeloid cells, and, in some, spicules of bone are present.

(3) EPITHELIOMA.

Epithelioma of the gums is generally of the squamous variety, although the columnar is at times seen attacking the muco-periosteum of the mandible. When starting in the gums it is due to some long-continued irritation, such as the ragged edge of a tooth or a badly-fitting denture. The disease is insidious, and often its presence is only recognised by the fact that after extraction the socket of the tooth does not show any tendency to heal. The ulceration spreads, involving the adjacent tissues, and is characterised by eversion of the edges and induration of its base. In the maxilla the growth of the epithelioma takes place principally in the direction of the antrum, so that the external appearances may be slight. This class of tumour, when it tends to spread to the antrum, has been named "creeping epithelioma," and is liable to be mistaken for necrosis of the jaw. As the disease extends, the lymphatic glands in the neighbourhood will become enlarged, the patient emaciated, with the characteristic cancerous cachexia, and if the disease is untreated, death from asthenia will generally ensue. The early recognition of epithelioma is most important, and as it may come under the notice of dental practitioners in its early stages its clinical signs should be thoroughly understood by them. All patients over 35 with ulceration of recent origin should receive close scrutiny. In doubtful cases, treatment for non-malignant ulceration may be tried ; if this fails, the diagnosis may be cleared up by obtaining a microscopical section.

The treatment consists in freely excising the diseased parts; the success of the operation depends upon the thoroughness with which it is carried out, and no hesitation must be shown in resecting a portion of the mandible, or removing the maxilla if necessary.

(4) MYELOID SARCOMA.

This form of tumour occurs in young people and grows rapidly. In character these myeloids are soft and vascular, and have a dark grey colour mottled with purple-coloured spots, presenting an appearance somewhat like a mulberry. In structure they are composed of a stroma of fibrous tissue containing multi-nucleated cells and exhibit a greater tendency to ossify than the fibromata. Their origin is from the bone itself, and many of them, as pointed out by Heath, are really outgrowths of myeloids involving the body of the bone.

(H) SYPHILITIC INFLAMMATION AND ULCERATION.

Syphilis may affect the gums and oral mucous membrane in all stages.

The primary lesion may occur on the gums, tongue or other parts, and often assumes an unusual appearance. Ulcers of peculiar appearance and uncertain origin should always be suspected and the possibility of their being of syphilitic origin carefully enquired into.

Secondary lesions may appear in the form of mucous tubercles and in almost any part of the mouth; the favourite situations are the inner surfaces of the cheeks, the edges of the tongue and the lips. In weak and debilitated patients the tubercle may break down, leaving an ulcer with a sinuous outline. The ulceration may extend and lead to extensive destruction of the tissue, followed, on healing, by adhesion of contiguous parts and extensive contraction.

In the tertiary stages the ulcerations are generally of a deep excavated character, and are preceded by gummata which, undergoing degeneration, produce the ulceration.

CHAPTER XIV.

Saliva.

The glands which pour their secretions into the mouth are the parotid, sublingual and submaxillary salivary glands, and the buccal mucous glands, the combined secretions being known as mixed saliva.

(A) PHYSICAL CHARACTERS.

Mixed saliva when freshly collected is a transparent, slightly opalescent and viscid fluid. On standing it becomes slightly turbid, owing to the precipitation of calcium carbonate. This salt is held in solution by carbonic acid, and with the escape of acid the calcium carbonate is deposited. The specific gravity of mixed saliva 1·002 to 1·006. The reaction in health is alkaline.

(B) COMPOSITION.

(1) MIXED SALIVA.

According to Halliburton, mixed human saliva contains water 994·10, solids 5·90.

(a) **Soluble organic matter.**

Mucin—precipitable by acetic acid.
Ptyalin—an amylolytic ferment.
Proteid—of the nature of a globulin.
Potassium sulphocyanide (0·10).

(b) **Epithelium.**

(c) **Soluble inorganic matter.**

Sodium chloride—most abundant.
Carbonates of sodium and calcium.
Potassium chloride.
Phosphates of calcium, magnesium and sodium.

(2) CHARACTERS OF THE DIFFERENT SECRETIONS.

(a) The parotid is clear, watery and, on standing, a deposit appears consisting principally of carbonate of lime. The total amount of solids is 0·3 to 0·5 per cent. There is no mucin.

(b) The submaxillary is of a thick, viscid character, contains mucin, and, on standing, deposits chloride of potassium and sodium.

The solids amount to 2·1 to 2·5 per cent. and consist of mucin and ptyalin, with potassium and sodium chlorides, and calcium and magnesium phosphates and carbonates.

(c) The sublingual is the richest in solids which amount to about 2·75 per cent. It is the principal source of ptyalin. The salt in greatest abundance is phosphate of lime.

(d) Mucous glands.—According to Bidder and Schmidt the secretion contains water, mucin and inorganic salts, the chief of which is sodium phosphate.

(C) QUANTITY SECRETED.

From one to three pints are said to be secreted during the day, of which about two-thirds is secreted by the parotid, and one-twentieth by the submaxillary gland.

In rare instances there may be a *complete absence* of saliva. In infants the salivary glands do not become functionally active until the child is four to six months old.

(D) THE SALIVA IN DISEASE.

So far as can be ascertained no extended enquiry into the conbitions of the saliva in health and in disease has yet been made. It seems more than probable that such an enquiry would reveal much useful information, and that an analysis of the saliva might often be employed as a confirmation of a suspected disease. Some diseases alter the character of the saliva. In acute fevers and inflammations the secretion is considerably diminished, the mucus rapidly undergoes fermentation, and clinging about the teeth, becomes hardened by evaporation of the fluid portions and gives rise to "*sordes.*"

In smallpox salivation is sometimes seen, while in diabetes, according to M. Oehl, sugar is present. In acute dyspepsia the saliva is often acid.

In the *Philosophical Transactions*, vol. B, p. 180, for 1889, there is an important communication which was made before the Royal Society by Messrs. Langley and Fletcher, "On the Secretion of Saliva." The chief results of their investigations are summarised as follows:—An increase in the percentage of salts accompanies an increase in the rate of secretion. Slowly secreted saliva, whether produced by a weak or a strong nerve stimulus to the chorda tympani nerve, contains a low percentage of salts.

Stimulation of the sympathetic nerve, on the other hand, produces a saliva with a higher percentage of salts. Sublingual saliva has a considerably higher percentage of salts than submaxillary saliva. If lithium citrate, potassium iodide, potassium ferrocyanide, and pilocarpine are injected into the blood, lithium can be detected in the first drop of saliva secreted, iodine after the first six drops; potassium cannot be detected at any stage of secretion. Dyspnœa and obstructed flow of blood through the gland decrease the rate of flow and increase the percentage of salts.

According to Dr. Michaels,[1] "the saliva contains definite chemical principles, which arrest or retard the progress of dental caries." He finds that in patients apparently immune to caries, the oral fluids are markedly different from those in whom caries is active.

Xerostomia, or "dry mouth," is a condition in which the secretion of saliva is arrested, and is very rare. It generally occurs in the female sex, and in persons of advanced age, and is probably of nervous origin, but its pathology is not clear.

(E) BACTERICIDAL PROPERTIES.

Sanarelli[2] states that human saliva possesses the power of destroying micro-organisms when their number is not considerable, and even when it fails to destroy them, as in the case of the germ of pneumonia, it seems capable of modifying their normal characteristics by weakening them, and then rendering them completely inactive. M. Sanarelli has experimented chiefly with the more common of the micro-organisms found in the mouths both of healthy and unhealthy individuals, namely: the staphylococcus pyogenes

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[1] *Cosmos*, December, 1900, p. 1297.

[2] *Centralblatt für Bakteriologie*, vol. x., p. 817.

aureus, streptococcus pyogenes, the bacillus of diphtheria, the micrococcus tetragenes, the diplococcus of pneumonia, the typhoid bacillus, and the cholera spirillum. The saliva was filtered with a Chamberland filter and experiments were practised by the plate method.

Triolo finds that saliva not filtered, as in Sanarelli's experiments, possesses decided bactericidal properties, and that the saliva from the parotid and submaxillary glands differed but little in their action.

Dr. Hugenschmidt, in an excellent contribution to the *Dental Cosmos* (October, 1896), records numerous experiments with filtered saliva, and has come to the conclusion that " the bactericidal action of the saliva appears to be very problematical." He was only able to detect it on the torula and staphylococcus aureus.

The saliva, Hugenschmidt considers, has an important mechanical action, as it dilutes the bacteria, glueing them together so that they are swallowed and destroyed in the stomach by the action of the gastric juice. He attaches some importance to the mucous secretions, remarking that although he has not had time to carry on experiments with regard to them, the researches of Wartz and Lermoyez into the bactericidal action attributable to the nasal mucus should be remembered. These investigators have shown that " after three hours' contact with the nasal mucus at 38° C., the spores of the bacillus anthracis are killed, while the staphylococcus aureus, the streptococcus and the Coli bacillus are greatly attenuated." The view that the potassium sulphocyanide in the saliva plays the part of an antiseptic agent is certainly not supported by the experiments recorded, indeed, the inference to be drawn from them is that the sulphocyanide possesses neither antiseptic nor bactericidal properties. It seems more than probable that the **protection of the oral cavity against pathogenic bacteria is due to phagocytosis.** Hugenschmidt refers to the chemiotactile properties of saliva, and shows that non-filtered human saliva possesses positive chemiotactile properties. This he demonstrates by the following experiments :—Human saliva ejected in the morning was left for some time in an experiment glass ; the upper part of the liquid, which had become clear, was then introduced in small quantities into capillary tubes which were each closed at one extremity ; the tubes were then inserted into the peritoneal cavity of a guinea-pig and left for eight hours, after

which they were removed, and on being examined, leucocytes were found to have formed a dense plug two millimetres long. In another experiment in which the saliva was kept for twenty-four hours in an oven at 37° C., and in which the number of microbes had greatly increased, the plug formed by the leucocytes in the capillary tube was visibly larger, thus showing that the attraction exerted by the leucocytes is in relation to the intensity of the culture, and consequently with the quantity of the microbian products present in the liquid. From these experiments one can deduce that when there exists in the interior of an alveolus after an extraction or in any other part of the buccal parietes, a cavity where the saliva can remain and become the medium of an abundant culture, the saliva presents chemiotactile properties in relation to the quantity of microbes which have developed in it. The leucocytes of the neighbourhood will be energetically attracted towards the diseased part, and will, in a very marked way, accomplish their protective action.

Experiments in which the saliva of a guinea-pig was introduced into the same animal's peritoneal cavity produced the same results as human saliva, thus demonstrating the fact that the saliva of one animal attracts the leucocytes of the same animal. Having shown that saliva possesses positive chemiotactile properties, experiments were made with the view of ascertaining whether the phagocytes of an animal are capable of englobing and digesting the microbes which are cultivated in the salivary secretions. That the phagocytes of an animal are capable of englobing and digesting the microbes which are present in the salivary secretions is shown by the following experiment.

Human saliva which had been left quiet—so as to clear it—was mixed with leucocytes from guinea-pigs. The mixture was then placed in an oven at 37° C. for an hour; the liquid was then placed on slides, fixed and coloured by Ehrlich's process. Microscopical examination of the slides showed that the leucocytes had taken up the microbes with great avidity. Similar experiments with the saliva of guinea-pigs, and leucocytes from the peritoneal cavity of the same animal, gave similar results. In another experiment recorded, the activity of the destruction of the microbes by the phagocytes is clearly demonstrated.

"A trace of saliva was taken from a guinea-pig, and from this preparations were made and stained, some with methyl blue and

others by the Gram method. This done, a wound was made in the gum and in the median line of the mandible, the mucous membrane being removed and the bone scraped. Twenty-four hours later the wound presented a white coating, consisting of leucocytes almost all polynuclear, some mononuclear. These leucocytes, by proper stainings, were found to contain an abundance of microbes similar in form and character of stain to those seen in the preparation of the saliva. A considerable number of the englobed microbes were less energetically stained than those from the surrounding liquid, thus demonstrating their degeneration."

In the experiments above recorded the saliva was used unfiltered and therefore mixed with microbes. To test whether filtered saliva possessed these chemiotactile properties the following experiment was carried out. Saliva, filtered through a Chamberland filter, was introduced into six capillary tubes, each of which had one end closed. In six other tubes cholera culture was introduced, and into another six physiological serum. These three bunches, separately attached, were placed in the peritoneal cavity of a guinea-pig and left for ten hours. Examination at the end of that period showed dense plugs of leucocytes in the tubes containing cholera culture, but few leucocytes in the tubes containing filtered saliva, and no trace of any in the tubes containing physiological serum.

"It would thus seem that the positive chemiotactile properties of saliva depend upon the presence of micro-organisms."

But phagocytosis is probably not the only means by which the oral cavity is rendered immune to pathogenic organisms, for it is more than possible that the epithelial cells and also the vital antagonism of the microbes lend their aid. The epithelial cells of the oral cavity are constantly being replaced; this desquamation being especially active during the act of mastication. Now although the epithelial cells do not possess phagocytic properties, nevertheless they are lined on the surface and also to a certain extent penetrated by scattered bacteria; the result is that the cells are dislodged by the saliva, and so carried away to the stomach to be destroyed.

(F) SALIVARY CALCULI.

A calculus occasionally forms in the ducts of the salivary glands. It may form in the substance of the gland, but this is very rare, as

a deposit formed in this situation is usually washed into the duct. If the deposit is situated in the substance of the gland, it gives rise to serious inflammatory trouble ; the flow of saliva from the duct of the gland is obstructed and the trouble may lead to abscess or even destruction of the gland.

Symptoms.—When a salivary calculus is deposited in the duct of a gland, the obstruction, which may be either as small as a millet seed or larger than a filbert, will give rise to a swelling of the duct and gland. Salivary calculi situated in the floor of the mouth may simulate ranula, from which they should be diagnosed by noting that in the case of salivary calculus the flow of saliva is stopped and that a small probe cannot be passed along the duct, while careful digital examination will reveal a hard concretion in the duct.

At times the presence of a salivary calculus in Wharton's duct will give rise to appearances and symptoms suggestive of malignant disease. In one case seen, the floor of the mouth was much swollen, the tongue pushed upwards, and there was a fungating excrescence surrounded by tissue in an indurated condition. The tissues covering the mandible and the neck were much swollen, and the lymphatic gland lying in the submaxillary region enlarged. The patient presented a cachectic appearance. The whole condition seemed typical of malignant disease.

In a case recorded by Mr. T. E. Constant, a calculus in the parotid duct caused symptoms simulating a dento-alveolar abscess.

Origin.—The origin of the formation of salivary calculi is not clear. It has been suggested that they arise in a manner similar to other calculi, by precipitation and accretion of the salts around a foreign body. This view is supported by the occasional presence of a nucleus of foreign matter within a salivary calculus. A minute foreign body can easily enter the main salivary ducts, and so form a nucleus.

Size.—Salivary calculi vary considerably in size. They may weigh as much as twenty-five grains, and the fusiform shaped ones reach one inch in length.

Treatment.—Treatment consists in making an incision over the hard swelling and removing the calculus. It is best to secure the concretion in a fixed position before making the incision. Cases remaining untreated may give rise to abscess, either in the region of the duct or in the gland itself. The abscess at times opens

externally, and thus gives rise to a salivary fistula. Salivary calculus as a deposit on teeth will be considered in the following chapter.

The following articles are given for reference.

Note of a case of Salivary Calculus presenting unusual symptoms (Shield, *Brit. Med. Jour.*, March 2, 1895).

Salivary Calculi (Futterer, *International Dental Jour.*, October, 1896).

Three somewhat uncommon cases of Salivary Calculi (Hulke, *Lancet*, 1894).

CHAPTER XV.

Deposits on Teeth.

(A) CALCULUS.

Several varieties of calculi are met with on the teeth, the commonest being that derived mainly from the saliva, and familiarly known as "tartar."

(1) **Situations.**—The lingual surfaces of the mandibular incisors and canines and the buccal surfaces of the maxillary molars are the general situations. The deposition of salivary calculus is favoured by (*a*) rough surfaces, as in "hypoplastic" teeth; (*b*) the presence of foreign bodies, such as wires or clasps on dentures which are not removed from the mouth for the purpose of cleansing.

(2) **Varieties.**—Clinically there are two varieties, "soft" and "hard." The distinction is purely arbitrary. The difference depends upon the rapidity with which the deposit takes place. **Rapidly deposited tartar** is soft in character, buff coloured and occurs in large quantities. **Slowly deposited tartar** is dark and hard in character, and is exceedingly tenacious to the tooth surface. The colour of the tartar is influenced by conditions which produce staining, such as tobacco smoking.

(3) **Mode of deposit.**—The deposit starts at the cervical margin, and as the calculus increases it tends to assume a wedge shape, the base being towards the tooth. The deposits may reach a large size. The deposit leads to more or less absorption of the alveolus and chronic gingivitis. The friction of mastication removes the tartar. Disuse of teeth favours its deposit.

The formation of the calculus is due to the precipitation of the salts from the saliva, calcium carbonate ($CaCO_3$) and calcium phosphate $Ca_2 (Po_4)_2$, which are insoluble in pure water, but soluble in water containing carbonic acid gas. When the saliva reaches

the oral cavity, the carbonic acid gas begins to pass out of solution and the lime salts to be precipitated.

(4) **Composition.**—Berzelius gives the following composition :—

Phosphates of lime and magnesia	79·0
Salivary mucus	12·5
Ptyalin	1·0
Animal matter soluble in HCl.	7·5
	100·0

This can only be approximate, and Dr. Stevenson gives the following analyses of the two varieties :—

	Water and Organic Matter.	Inorganic.
Soft tartar	21·48	78·52
Hard tartar	17·51	82·49

The deposit found on the buccal surfaces of the maxillary molars contains almost entirely calcium carbonate. The deposit on the lingual surfaces of the mandibular incisors contains much more calcium phosphate than carbonate, owing to the excess of the former in the submaxillary secretion.

(5) **Treatment.**—The treatment of salivary calculus consists in thoroughly removing all the deposits and polishing the surfaces of the teeth. For the removal, a large spoon-shaped excavator or curved enamel chisel may be used in addition to specially designed instruments. Cushing's and Howes' sets are useful forms. The force for detaching the deposit may be used in a direction towards the gum or away from it. Force is used towards the gum when there is much tartar, and away from it when the quantity is small. When using force in a direction towards the gum, the right hand should be steadied by placing a finger or fingers upon the teeth, the cutting edge of the instrument being placed upon the tartar, and a pushing motion used, when the tartar will be found to come off in large flakes. The greater part of the tartar can be removed in this way, the remaining adherent portions being removed in a direction from below upwards, the instrument being prevented from slipping by supporting the hand on the cutting surface of the teeth. When there is much deposit it will often be necessary to see the patient more than once, as it is quite impossible to effect complete removal at the first sitting. At the completion of the scaling, the teeth must be polished with fine pumice applied by means of a circular brush on the dental engine.

(B) SUB-GINGIVAL DEPOSITS.

In dealing with marginal gingivitis and also chronic periodontitis, reference was made to the frequent presence of **calculus under cover of the gum margin.** In character it is hard and dark (fig. 543), and is more frequent in the approximal than the labial and palatal surfaces. The source of the deposit is not clear. It probably arises from some abnormal secretion of the gingival organ in combination with the discharges from the marginal gingivitis. The presence of the calculus is generally marked by a hyperæmic condition of the gum margin. Occasionally the gum tissues appear quite healthy, but this does not indicate that marginal gingivitis has not occurred at some period.

FIG. 543. — Showing well-marked deposit around the neck of a mandibular molar.

FIG. 544.—A maxillary molar showing large deposit of calculus on the apical portion of the palatine root.

FIG. 545.—A maxillary molar showing irregular deposit of calculus over a large portion of the surface of the root.

Treatment.—The deposit must be removed and the condition of the gum or periodontal membrane accompanying it treated. The roots of teeth which have been the subject of chronic suppurative periodontitis are often covered with a calcareous deposit (see figs. 544 and 545). Analyses of these deposits show them to be composed mainly of phosphates. Oxalates are sometimes present.

The deposit noticed in teeth removed on account of gouty periodontitis was referred to on page 442.

(C) STAINS.[1]

(1) Green stain.—A green stain is often met with on the teeth, more especially in the young. The colour varies from a greyish

[1] The matter contained in the following section relating to "stains," has been obtained almost entirely from an excellent paper by Dr. Miller, *Cosmos*, April, 1894, entitled "The Deposits upon the Teeth with Special Reference to Green and Metallic Deposits."

green to bluish green. It appears more frequently on the maxillary than the mandibular teeth. The labial surfaces of the anterior maxillary teeth are the most frequent sites, the discolouration commencing at the gingival margin and encroaching on the surfaces in a direction towards the cutting margin. At times more than half the surface is covered. The stain may extend to the approximal or even gingival surfaces. The stain may be limited to any pits, grooves, or depressions present on the surface of the tooth. The green stain is nearly always preceded by lack of cleanliness on the part of the patient. The stain is intimately connected with the enamel cuticle. Removal of the stain by acids leaves a colourless surface behind. Green stains may occur on adult teeth beyond the enamel margin.

Cause.—The origin of green stain is not clear. The following facts are known: the colouring matter is characterised by its insolubility in nearly all the ordinary solvents, viz.; glycerine, alcohol, chloroform, turpentine, &c.; tincture of iodine has no marked decolourising effect. The colouring matter is rapidly destroyed by chlorine and hydrogen peroxide.

Calcination experiments show that the green stain deposit may be of an organic or inorganic nature. The theory that the green stain is produced by chlorophyll is negatived by the fact that the green stain is not soluble in ether, chlorophyll being readily soluble in ether. In some conditions there is reason to believe from experimental investigations that the green colour is traceable to the presence of sulpho-methœmoglobin.

The relation of green stain to enamel decalcification is not clear. In the majority of cases on removal of the stain the enamel appears quite normal, in others the surface shows signs of decalcification.

Treatment.—The stain should be removed by means of suitable wheels or brushes on the dental engine, a little powdered pumice stone being used to increase the abrasive action. Acid applications are *not* to be used.

(2) **Metallic stains**—(*a*) *Copper.*—Workers in copper invariably show a green stain upon their teeth. Miller found in 150 who had worked for more than a year, distinct discolouration in all. The colour varies from green to dark dirty green, reddish green, bluish green, greenish blue to bluish purple, the latter being seen in "Phosphor-bronze" workers. Persons using brass musical instruments at times show staining of the teeth.

In copper workers the gingival margin is hyperæmic, owing to irritation from the more or less oxidised particles of the metal which may have worked their way up into the gums.

The stain from the use of copper amalgam was referred to on p. 319.

(*b*) *Iron.*—Iron seems to produce a brown stain of varying tints. In workers in iron Miller found that nearly all showed brown spots or deposits on their teeth, the mandibular teeth being more frequently the seat of discolouration than the maxillary. Medicines containing iron may stain the teeth if the mouth is not cleansed each time after taking the medicine. The forms of iron detrimental to the teeth are those containing free acid, such as the perchloride.

(*c*) *Mercury.*—Deposits of mercury in the form of sulphide are seen in teeth filled with amalgam. They may occur also on the teeth of patients subjected to prolonged mercurial treatment, the mercury affecting the teeth through the saliva. The stain may be due to the use of mouth washes containing mercury. The presence of the mercury on the teeth can be demonstrated by chemical tests.

(*d*) *Lead.*—Lead poisoning may produce a blue line in the gum margins (p. 463). According to Hirt,[1] in chronic lead poisoning the teeth are discoloured and appear dark brown at the necks, shading to light brown towards the occluding surfaces. This staining is not always present.

(*e*) *Nickel.*—A tooth from the mouth of a worker in nickel is figured by Miller. The deposit is thick and of an opaque bluish to greenish black colour.

(*f*) *Silver.*—Silver, when used in the mouth, produces a dark stain, which is due to the formation of the sulphide. Silver employed in the form of silver nitrate stains the dentine and cementum black.

Treatment of stains.—The various stains can be easily removed by the use of abrasives.

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[1] Quoted by Miller.

CHAPTER XVI.

Odontomes.

Mr. Bland Sutton defines an odontome as a "tumour composed of dental tissues in varying proportions and different degrees of development, arising from tooth germs or teeth still in the process of growth."

Odontomes may be classified as follows :—

(A) Aberrations of the enamel organ.
Epithelial odontomes.

(B) Aberrations of the follicle.
(a) Fibrous odontomes.
(b) Follicular odontomes.
(c) Cementomes.
(d) Compound follicular odontomes.

(C) Aberrations of the papilla.
Radicular odontomes.

(D) Aberrations of the whole tooth germ.
Composite odontomes.

(A) ABERRATIONS OF THE ENAMEL ORGAN.

Epithelial odontomes.—These odontomes probably originate in aberrations of enamel organs of teeth which should normally go on to full development, or, as Mr. Eve suggests, from epithelial ingrowths around the dental alveoli, some of which may possibly be regarded as the representatives of teeth suppressed in the process of evolution.

The growth is often insidious and its progress slow, extending in some cases over a period of twenty years. A growth in the neighbourhood of the alveolus is noticed, "the swelling gradually increases and the teeth overlying it become loosened and may fall

out. Not infrequently a glairy fluid is discharged from a vacant alveolus, the orifice of which may become ulcerated."

According to Sutton, "most of the patients come under observation at the age of about twenty years, although the disease may occur at any period from infancy to old age. More commonly the lower jaw is affected, and the molar region is usually, though not exclusively, involved.

"In typical specimens the tumour displays on section congeries of cysts, very various in size, but rarely exceeding an inch in diameter. The cysts are separated by thin, fibrous septa, in some cases by osseous tissue. The cavities are, as a rule, filled with mucoid fluid of a brownish colour. The growing portions of the tumour are of a reddish brown colour, not unlike that of a myeloid sarcoma.

FIG. 546.—From the *Transactions of the Odontological Society.*

"Histologically, these tumours are composed of branching and anastomosing rods or columns of epithelium, portions of which form alveoli. The stroma is composed of fibrous tissue; when abundant, embryonic tissue in various stages is present. The cells occupying the alveoli vary in form; the outer layer may be columnar, whilst the central cells degenerate and give rise to a reticulum of stellate cells resembling in structure the stratum intermedium of the enamel organ."

The appearance of these tumours is shown in figs. 546 to 548. The cysts are probably produced by colloid degeneration of the epithelial cells.

The tumour shown in fig. 548 should probably be included under this heading. The specimen is preserved in the Museum of the Royal College of Surgeons, and consists of the right side of the

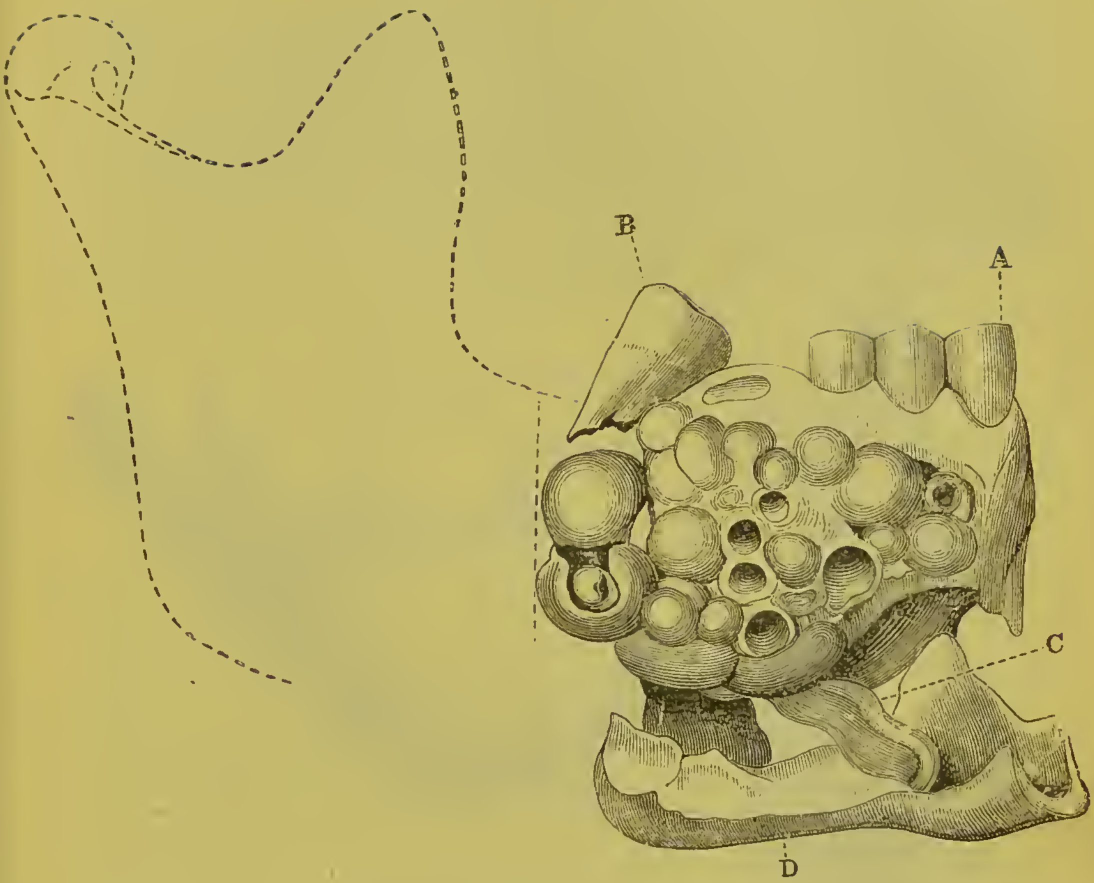

FIG. 547.—(A) Canine; (B) second molar; (C) mandibular nerve; (D) base of horizontal portion of mandible. (From Heath.)

FIG. 548.—One-third natural size (College of Surgeons, No. 2194). (From the *Transactions of the Odontological Society*.

mandible, which is enormously distended by a single cyst. Mr. Eve[1] thus describes the specimen, "It contains no trace of a tooth, and the structure of its walls shows that it is not dentigerous or follicular in the strict sense of the term, for it is lined with a thick layer of small round-celled epithelium. This may have originated from the expansion of a rudimentary enamel organ owing to the collection of fluid in its interior."

FIG. 549.—From Salter.

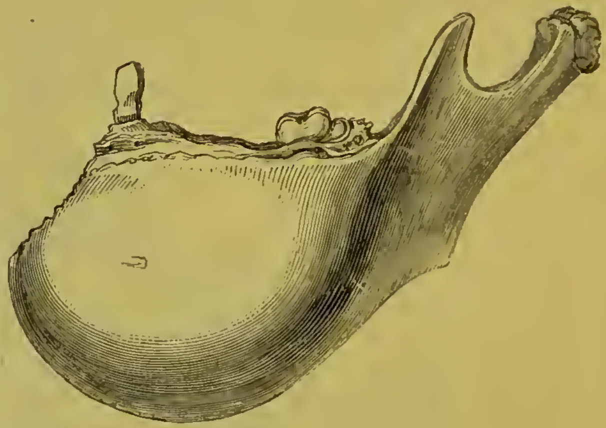

FIG. 550.—From Salter.

Epithelial odontomes are analogous to the cystic sarcomata of old writers. Mr. Eve was the first to draw attention to the real nature of these growths, and terms them "multilocular cystic epithelial tumours." In describing the septa of this form of odontomes it will be noticed that they are at times ossified; if this ossification extends so that the greater part of the tumour is affected, we then have a **calcified epithelial odontome**. A tumour apparently belonging to this class has been described by Mr. C. Tomes in the *Transactions of the Odontological Society*, vol. xviii., p. 62.

Symptoms.—The epithelial odontomes give rise to slow and painless expansion of the plates of bone of the jaw. The swelling is often lobulated, and may therefore be mistaken for a myeloid

[1] *Trans. Odonto. Soc.*, vol. xvii., p. 62.

sarcoma. In conjunction with the swelling there will be the absence of one or more teeth.

The treatment consists in opening up the cyst with suitable instruments, taking care to break down all the loculi and thoroughly remove the cyst wall. The cavity must then be packed with lint or tape dipped in carbolic acid 1 in 20 solution. This assists in the destruction of any remaining cyst wall, and promotes the formation of granulations, which in time completely close in the cavity.

(B) ABERRATIONS OF THE FOLLICLE.

Under this heading are included odontomes which arise from the tooth follicle or sac.

In order to trace the development of the various tumours included under this heading it will be useful to recount one or two anatomical points.

If a section of a jaw be made so as to include a tooth about to erupt it will be noticed that the tooth is surrounded by a membrane (the tooth follicle) and that both tooth and membrane are completely enclosed in a capsule of bone. The membrane is adherent to the root of the tooth but is slightly separated from the enamel, and in the space between the enamel and the tissue a small quantity of fluid sometimes collects. If the quantity secreted is excessive the walls of the bony capsule will gradually expand and a follicular odontome or dentigerous cyst will be formed. Should the follicular wall undergo hypertrophy the odontome will be of a fibrous character. The hypertrophied follicle may become calcified and so give rise to a cementome; the function of the follicle being to form cementum, it is natural that the tissues resulting from the hypertrophied follicle should be cemental in character. The thickened follicle may calcify *en masse* or only in a sporadic manner. In the latter case the tumour will be composed of numerous small denticles embedded in a thickened wall and is classified as a compound follicular odontome.

(1) **Follicular odontomes.**—A follicular odontome, as stated above, is the result of an excessive secretion of fluid between the tooth and the follicle. As the fluid collects the bony surroundings of the tooth are absorbed and at the same time fresh bone is deposited on the outside of the jaw (figs. 549 and 550). In this way the jaw may gradually become enormously distended as shown in fig. 551.

In the maxilla the cyst may encroach upon the cavity of the antrum.

The walls of the follicular odontomes are formed by fibrous tissue lined with epithelium. A tooth is generally found projecting

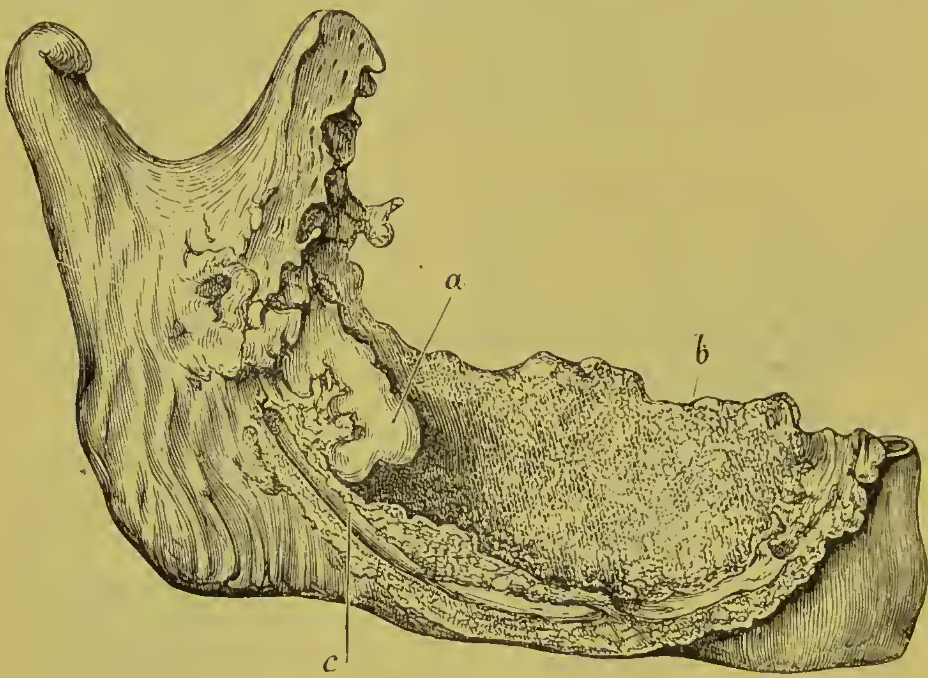

Fig. 551.—(*a*) Tooth; (*b*) inner wall of cyst; (*c*) canal for mandibular nerve. (From Heath.)

Fig. 552.—A follicular odontome (natural size). From the *Transactions of the Odontological Society* (vol. xxvi., p. 182).

into the cavity, the roots, frequently only partially formed (fig. 552), being embedded in the cyst wall. The tooth sometimes lies free in the cavity of the cyst.

The fluid from a follicular odontome is generally of a yellowish glairy character and contains crystals of cholesterin.

The walls of follicular odontomes are very prone to undergo calcification. An interesting example is described by Salter[1] (fig. 553). The cyst had invaded the antrum. An interesting feature of this case was the development of the cyst in connection with a supernumerary tooth. Suppuration is another secondary change, and is more commonly met with, according to Sutton, in the lower animals. Complete disappearance of the fluid contents of the cyst have been observed by Heath.[2]

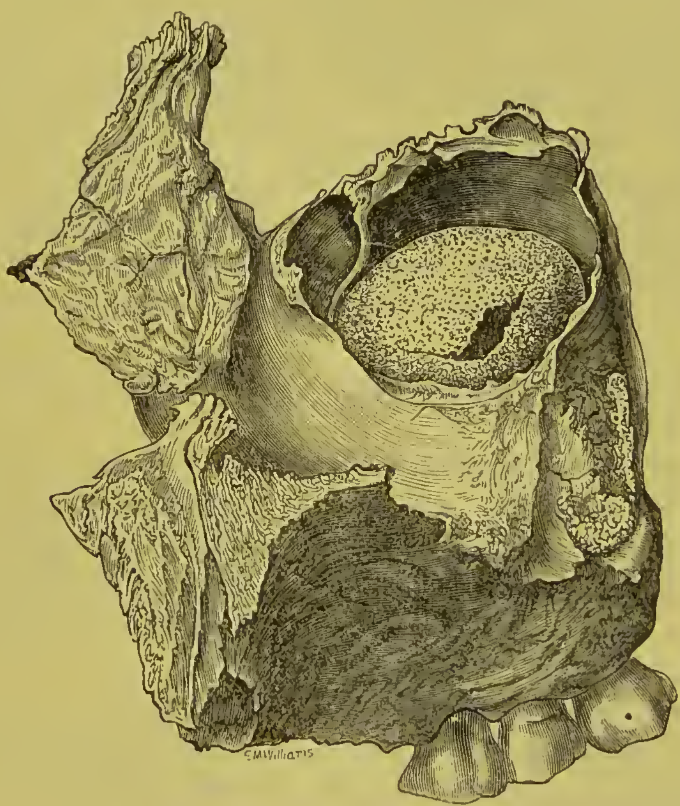

FIG. 553.

Follicular odontomes but rarely occur in connection with deciduous teeth.

Cases of multiple cysts have been recorded. In a case recorded by Salter cysts occurred on both sides of the maxilla of a young girl. In a case recorded by Mr. Hern[3] there were three cysts; two

[1] "Dental Pathology and Surgery," p. 219.

[2] "Injuries and Diseases of the Jaw," Fourth Edition, p. 189.

[3] *Trans. Odonto. Soc. of Great Britain*, vol. xxvi., New Series, p. 91.

in the maxilla in connection with the lateral incisors, and one in the mandible around the unerupted left canine.

Follicular odontomes may develop at any age, but they are generally met with in young adults.

Signs and symptoms.—Follicular odontomes produce slowly-growing swellings leading in the mandible to an expansion of the walls, while in the maxilla they frequently invade the antrum, giving rise to a distension of its walls. No pain is usually experienced unless suppuration has taken place. Upon manipulation of the swelling the bony walls will often (but by no means always) yield to pressure and resume their shape as soon as the pressure is removed, the movement producing a curious kind of crepitation which has been termed "crackling." Occasionally the bony wall does not exist and distinct fluctuation can be obtained. There is usually a history of absence of a tooth in the region of the swelling, and this is an important diagnostic sign. In the case of a cyst developing in connection with a supernumerary tooth this sign would naturally be absent.

The **differential diagnosis** from other tumours in the mouth is dealt with in Chapter xxvii.

Treatment.—Treatment consists in removal. The muco-periosteum covering the cyst wall is first reflected and the bony wall divided and in great part removed. The tumour is then dissected out. The wound thus left is packed with iodoform gauze and allowed to heal by granulation. It is frequently advisable to break down and crush in the bony walls.

(2) **Fibrous odontomes.**—The external parts of the tooth sac are composed of fibrous tissue, and if this tissue become hypertrophied a fibrous odontome is formed. The nature of these odontomes is shown in fig. 554. Examined microscopically the thickened follicle is found to be composed of fibrous tissue, laminated in character and at times partly ossified. In the lower animals these odontomes are generally symmetrical, and in one case, that of a dasyure, the skeleton was softened by rickets. The presence of rickets in this case may have been an accidental circumstance, but in view of the fact that rickets seems to thicken the membrane covering growing bone, it is not improbable that there may be some relationship between rickets and this class of odontome.

Bland Sutton contends that many of the fibroid and fibro-cellular tumours recorded in Heath's "Injuries and Diseases of the Jaws" are really examples of this form of odontome.

An odontome of this variety is described by Jordan Lloyd, under the name of endosteal fibroma.[1] The patient, a little girl aged eight, was the subject of a large swelling on the right side of the mandible, extending from the angle of the bone to within an inch of the symphysis. The deciduous and first permanant molars on that side were missing, the former having been extracted. The tumour was exposed by removing the outer plate of bone, and was

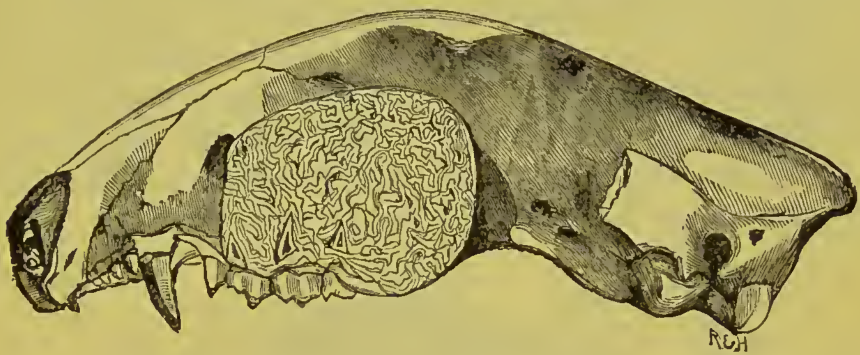

FIG. 554.—Portion of the skull of a dasyure, showing a fibrous odontome in section. The tumour was intimately connected with a molar tooth.—From the *Transactions of the Odontological Society.*

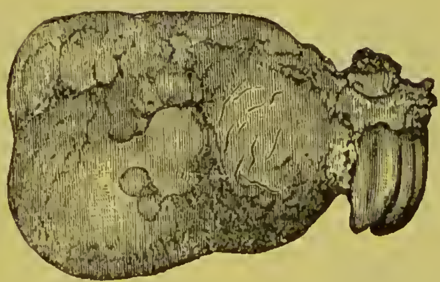

FIG. 555.—From the *Transactions of the Odontological Society.*

shelled out of its bed without difficulty. It was found to be attached only at its lower and posterior part, and was lying over the first permanent molar, which was displaced to the lower border of the mandible. The following is the description of the tumour: "It measured nearly three inches in length, two in depth, and nearly one and a half in thickness. It is of uniform pearly colour, and of a regular tough consistence. At its lower and hinder part is a

[1] *Jour. Brit. Dent. Assoc.*, vol. xiv., p. 564.

large, well-formed permanent molar tooth, lying with its crown against the tumour, to which it is held in organic connection by a delicate fibrous membrane, passing from the outer surface of the tooth roots to the delicate connective-tissue capsule, which covers the tumour." A microscopical examination showed the growth to be "closely allied to fibrous tissue on the one hand, and to fibrous cartilage on the other, rather nearer the former than the latter."

(3) **Cementomes.**—These odontomes are produced by the ossification of fibrous odontomes, the resulting tissue being cementum. They are rare in man, but common in horses and ruminants. The growth resembles cementum in character, and its growth causes a hard tumour of the jaw, generally painless in the early stages, but later giving rise to pain, which is apt to be mistaken for periostitis or necrosis. Fig. 555 is the drawing of a cementome recorded by

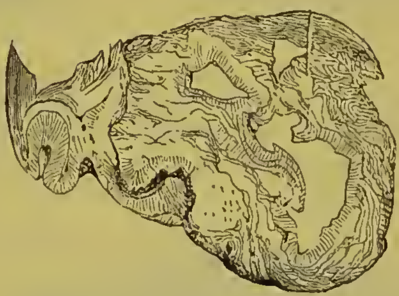

FIG. 556.—Section through fig. 555. From the *Transactions of the Odontological Society.*

Dr. Forget; the odontome was about the size of a pigeon's egg and came away with a carious molar, which he decided to extract before operating for the tumour.

(4) **Compound follicular odontomes.**—Under this heading are described cysts which contain a great number of small masses of dental tissue, and in some instances bone. Several cases have been reported in man, while Logan has recorded one in a horse, and Bland Sutton one in a thar. Of the cases recorded in man, the first occurred in the practice of Mr. Tellander, of Stockholm, and is reported in the *Transactions of the Odontological Society* (vol. iii., p. 282, old series). The patient was a female, aged 27; the cyst developed in the right maxilla, and was first noticed about the age of 12. The first molar, the two premolars and the canine were absent. When seen by Mr. Tellander, suppuration had

supervened, and probably some of the calcified contents of the cyst had been lost. Twenty-eight denticles were removed—nine were tiny single teeth, each perfect in itself, with conical roots and crowns tipped with enamel. Six masses were built up of adherent single teeth, while the remaining denticles were exceedingly small. In fig. 557 A will be seen drawings of some of the denticles.

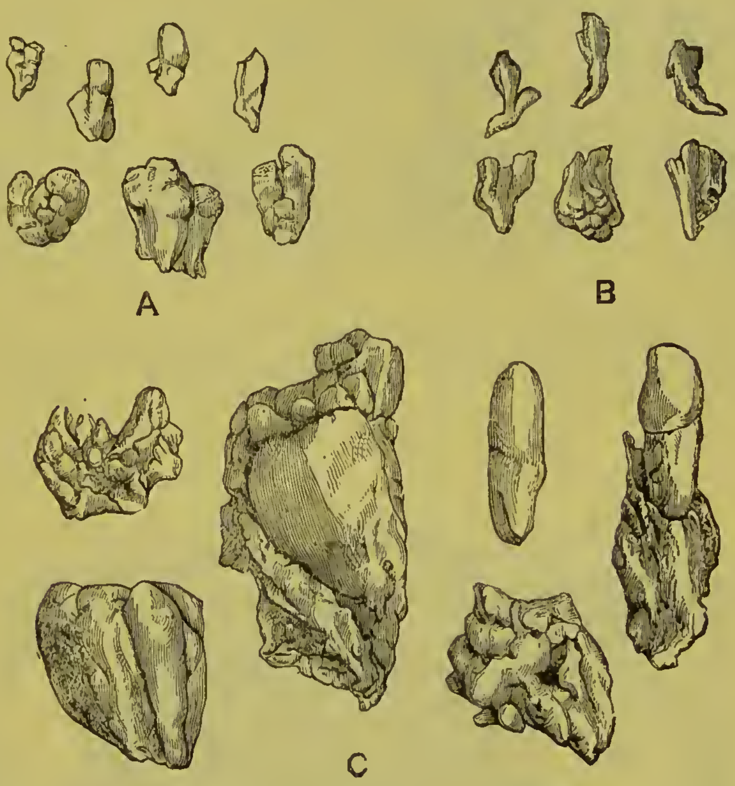

FIG. 557.—From the *Transactions of the Odontological Society.*

The second case recorded[1] was in the practice of Mr. Mathias, and occurred in a Hindoo, aged 25, in the region of the central and lateral incisors. This case was also suppurating. Fifteen fragments were removed from the cyst. These are shown in fig. 557 C. Two of the fragments were fairly formed teeth, and to one bone similar to that of the alveolar process was attached.

The third example recorded of this class of cyst came under the notice of Mr. Sims.[2] The patient was a boy, aged 10, and the swelling occupied the region of the right maxillary lateral incisor

[1] *Trans. of the Odonto. Soc.*, vol. iii., p. 366 (old series).
[2] *Journ. of Anatomy and Physiology*, vol. xxi., 1887.

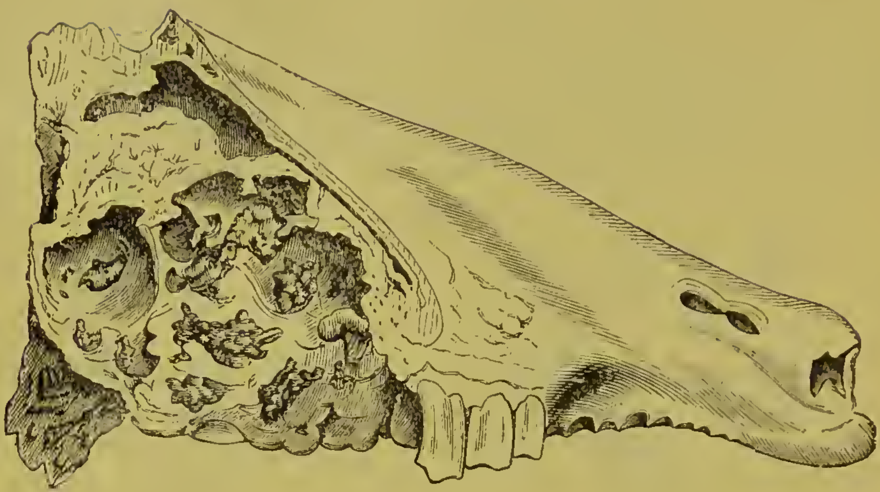

Fig. 558.—Sagittal section of the right maxilla of a thar, showing the cyst *in situ.*—From the *Transactions of the Odontological Society.*

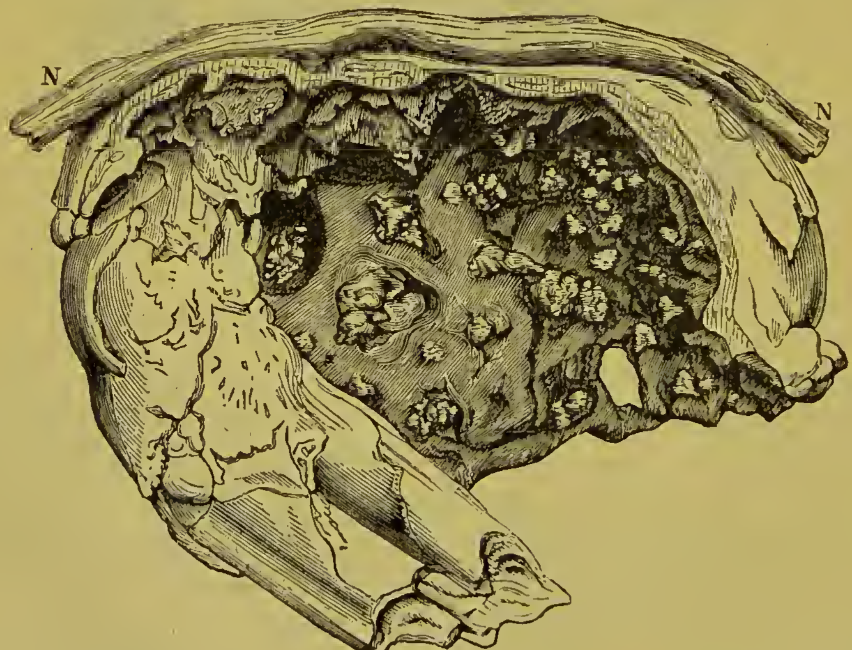

Fig. 559.—(N) The maxillary division of the fifth nerve.—From the *Transactions of the Odontological Society.*

and canine. The corresponding deciduous teeth had never erupted. This cyst had not suppurated. On being opened it was found to contain about forty small denticles. Types of these are seen in fig. 557 B.

A fourth case has been recorded.[1] The patient was a boy (age not stated). The swelling invaded the right antrum and caused bulging of the external wall of the antral fossa. The cyst was supposed to have arisen in connection with the permanent canine. Over fifty denticles, which consisted entirely of cementum, were removed.

The case described by Mr. Bland Sutton in the thar[2] has thrown light upon the nature of these interesting cysts. He describes the condition he found as follows: "Each antrum contained, in fact, a cyst with dense thick walls. The outer shell was of bone, lined with thick fibrous tissue. The interior was occupied with denticles, fragments of cementum, and bone of varying shapes and sizes, amounting to nearly three hundred. Those in the middle of the cyst were glued together by thick pus mixed with hay and chaff, whilst the peripheral fragments were embedded in fibrous tissue or sprouted from the cyst wall" (figs. 558 and 559).

The **treatment** of compound follicular odontomes is similar to that of the follicular odontomes already described.

(C) ABERRATIONS OF THE PAPILLA.

Radicular odontomes, which are included under this heading, arise after the completion of the crown and during the formation of the root. A classification of radicular odontomes may be made as follows:—

(1) Radicular dentomes.
(2) Radicular osteo-dentomes.
(3) Radicular cementomes.

In the first, dentine is the principal constituent of the growth; in the second, osteo-dentine; in the third, cementum.

Radicular odontomes are rare in man, but comparatively common in the lower animals, more especially those whose teeth grow from persistent pulps. In animals radicular odontomes are

[1] *New York Medical Journal*, November 17, 1894.
[2] *Trans. of the Odonto. Soc.*, vol. xx., new series, p. 185.

not uncommonly multiple, and in one instance recorded by Bland Sutton[1] an odontome existed at the base of each incisor tooth in the maxilla and mandible.

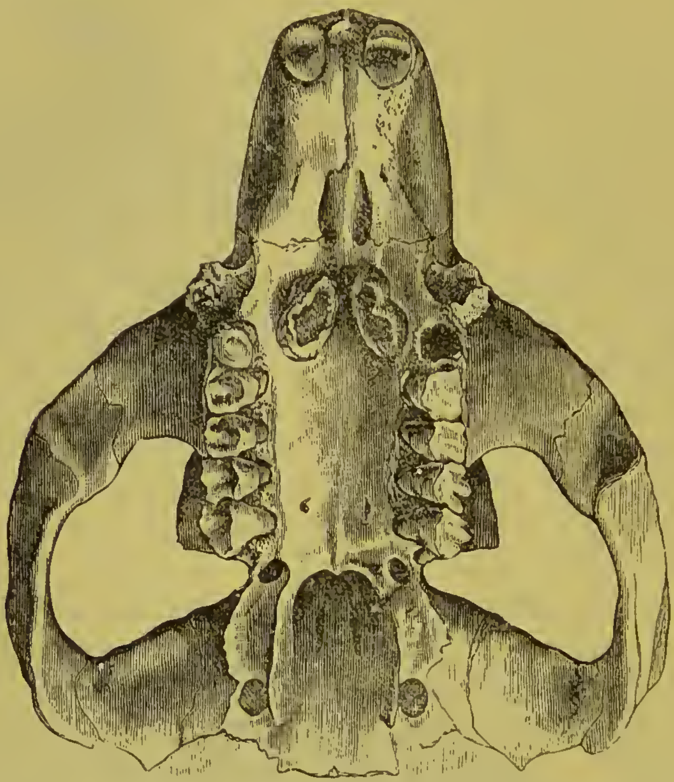

Fig. 560.—Hard palate of marmot. Odontomes connected with the roots of the upper incisor teeth appearing in the hard palate.—From the *Transactions of the Odontological Society.*

Fig. 561.—From the *Transactions of the Odontological Society.*

The specimen shown in fig. 561 was removed by Mr. Hare, of Limerick, from the maxilla of a man aged 45. The patient had suffered much pain, and a sinus connected with the growth had

[1] *Trans. of the Odonto. Soc.*, vol. lxx., p. 65.

opened on the face. Mr. C. Tomes made a microscopical examination of this specimen, the details of which are to be found in the *Transactions of the Odontological Society* (vol. iv., p. 82).

Sections were made through the tumours at the position *a b* and *d d*.

Along the line *b c* the tissues displayed were, on the outside, a thin layer of cementum, next a layer of dentine and next a solid mass of bony tissue.

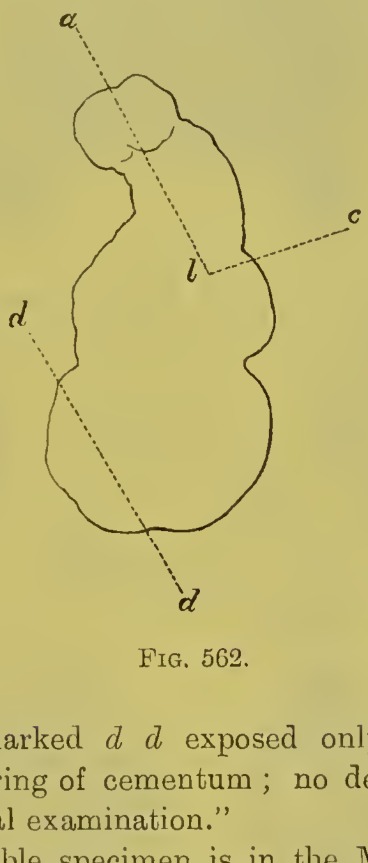

FIG. 562.

"The section marked *d d* exposed only the irregular, bony tissue, with its covering of cementum; no dentine was found here, even on microscopical examination."

Another remarkable specimen is in the Museum of the Royal College of Surgeons of England (figs. 564 and 565). This was examined by Mr. Salter.[1]

The outer layer consists of cementum, inside this for a distance of about two-thirds the circumference is a layer of dentine, the remaining portion of the growth being composed of a confused mass of bone structure and dentine structure, arranged around and separating an elaborate vascular network of the same character as that of a dentine pulp.

[1] "Dental Pathology and Surgery," by S. J. Salter.

FIG. 563.—Microscopical section taken along the line *a b*, fig. 562.

FIG. 564. (Salter.)

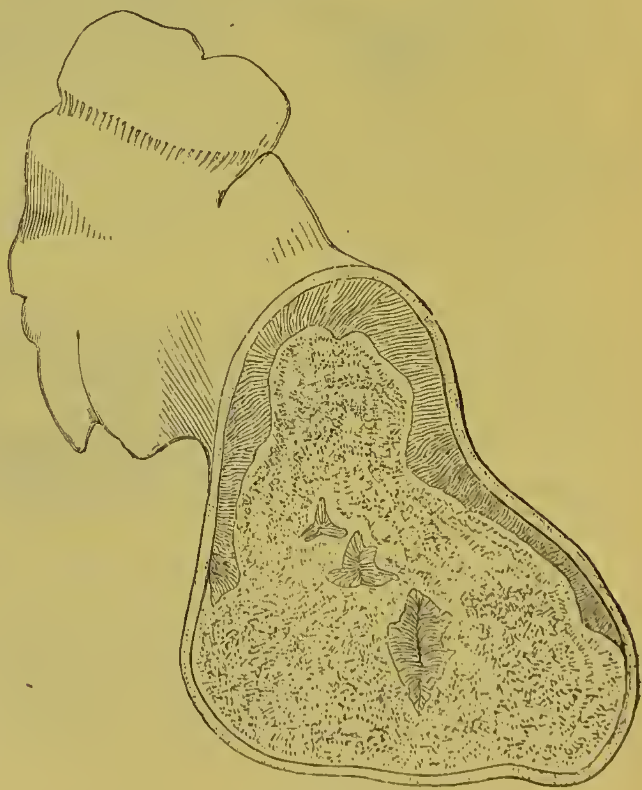

FIG. 565. (Salter.)

The odontome shown in fig. 566 was described by Professor Windle and Mr. Humphreys.[1] It occurred in a man aged 25, and was situated in the mandible on the right side in the region of the second molar. The specimen is probably a cementome.

An odontome of this class, which occurred in the practice of Mr. R. Markham, is shown in figs. 567 and 568.

FIG. 566.

FIG. 567.

FIG. 568.

From the *Journal of the British Dental Association.*

FIG. 569.

FIG. 570.

From the *Journal of the British Dental Association.*

The tumour was examined and described by Mr. G. Watson.[2]

The odontome was in connection with the left third maxillary molar, and must have considerably encroached upon the cavity of

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[1] *Jour. of Anatomy and Physiology*, vol. xxi., p. 665.
Jour. of the Brit. Dental Asso., vol. xv., p. 667.

the antrum. The structure consists of an outer layer of irregularly-laminated cementum, highly vascular and containing numerous well-marked lacunæ. The main portion is composed of a narrow band of very intricate convolutions of white and yellow tissue, namely, vaso-dentine and osteo-dentine (fig. 568).

The odontome seen in figs. 569 and 570 was sent me to examine by Dr. Salisbury Sharpe. The abnormality consists in a large globular swelling about the size of a full-grown acorn, involving one root of a four-rooted maxillary molar. On dividing the tooth with a saw, the globular swelling was found to be hollow, and lined with a tissue which presented distinct evidence of having been soft in character. A thin section was then obtained.

Fig. 571.—From the *Journal of the British Dental Association.*

The original pulp chamber it will be noticed is very nearly filled up with a form of secondary dentine (fig. 571 *a*), presenting but little structure beyond a few blood vessels. The globular swelling itself is bordered by a layer of cementum (fig. 571 *b*), the lacunæ being more numerous in the right side of the specimen, as seen in the figure. This outside cemental layer is bounded :—

(i.) Internally on the right side with dentine fairly regular in

type, and continuous with the dentine of the main body of the tooth. This dentinal layer is succeeded by one cemental in character.

(ii.) Towards the base the cemental layer is still covered by a dentinal tissue presenting few tubuli.

(iii.) To the left the inner covering of the cemental layer is for the most part composed of tissue irregular in type, containing large blood vessels and irregularly-shaped lacunæ, with a few dentinal tubes (fig. 571 *d*) and is, as far as can be ascertained, continuous with the secondary dentine in the pulp chamber. Inside this layer is a tissue of rather different pattern, but still cemental in character. At one spot (fig. 571 *c*) a transverse section of dentine appears.

The aberration seems to have consisted of an overgrowth of one radicle of the pulp, followed by calcification in a direction from without inwards.

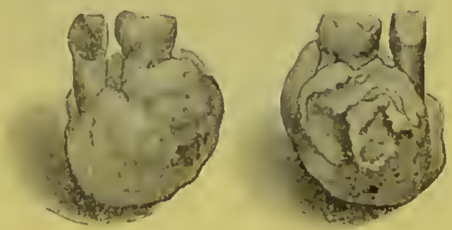

Fig. 572. Fig. 573.

Copied by permission from Wedl's "Atlas of the Pathology of the Teeth."

A growth (figs. 572 and 573) which is probably a type of radicular odontome, is described in Wedl's "Atlas of the Pathology of the Teeth" (Second Edition).

The patient was a boy, 11½ years of age, and the swelling occurred in the mandible, in the region of the first deciduous molar. The tumour was very sensitive to pressure, owing to severe periostitis. After removal it was found to be composed of a mass of tissue, about the size of a large cherry, intimately coalescent with the deciduous canine and first molar. It was covered with a distinct membrane of connective tissue which was closely adherent to the hard tissue. A section of the growth showed that it consisted of hard tissue containing cavities filled with connective tissue and blood vessels (fig. 574). The distal root of the molar

showed considerable absorption. Microscopical examination showed the hard tissue to be a rudimentary dentine which has remained stationary at the stage of development of globules with interglobular spaces.

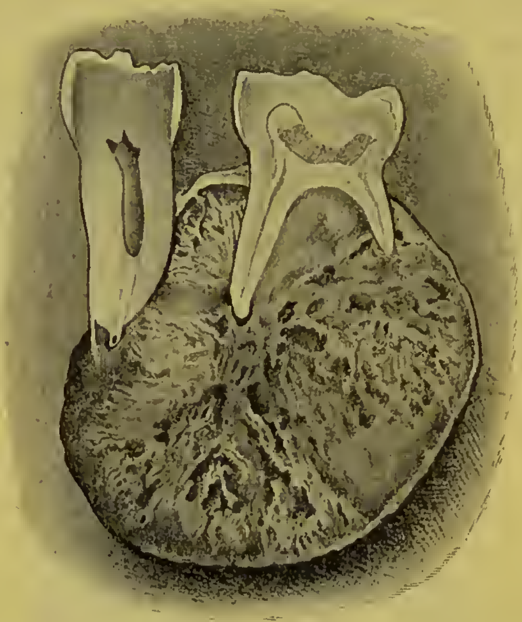

FIG. 574.—Copied by permission from Wedl's "Atlas of the Pathology of the Teeth."

(D) ABERRATIONS OF THE WHOLE TOOTH GERM.

Composite odontomes are included under this division. They consist of irregularly-shaped calcified masses, and are composed of enamel, dentine and cementum disposed in apparently no definite arrangement. They probably arise from an abnormal growth of all the elements of a tooth germ, namely, enamel organ, papilla and follicle. They have so far only been met with in man. Composite odontomes may occur in either the maxilla or the mandible. In size they vary. In one recorded by Mr. J. J. Andrew,[1] occurring in the right maxilla, the length was $1\frac{5}{8}$ inches; girth $4\frac{1}{2}$ inches; width $1\frac{1}{4}$ inches and the weight was estimated at 500 grains. In the one shown in fig. 575 and recorded by Heath[2] the

[1] *Trans. Odonto. Soc.*, vol. xxvii., p. 42.

[2] "Injuries and Diseases of the Jaws," Fourth Edition, p. 319.

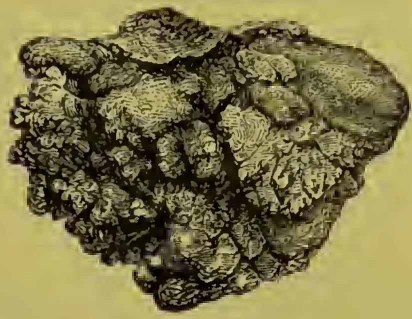

Fig. 575.

Fig. 576.—Section of odontome shown in fig. 575.

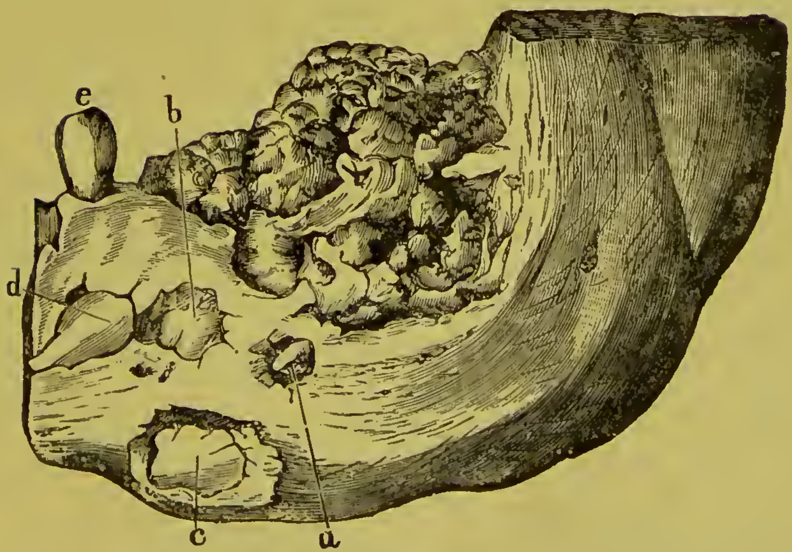

Fig. 577.—Portion of a mandible showing a composite odontome in position. (From Heath.)

measurements were $1\frac{1}{2}$ inches antero-posteriorly, 1 inch transversely and $1\frac{1}{4}$ inches from above downwards; weight 315 grains.

According to Bland Sutton[1] the largest odontome known to have grown in the human antrum is preserved in the museum of Guy's Hospital. It weighed nearly fifteen ounces. The clinical history of the case was recorded by Hilton in the Guy's Hospital Reports, 1836, vol. i., p. 493,

The odontome is not always the aberration of one tooth germ, for in some examples there is evidence of at least two teeth germs being implicated in the growth.

On section, composite odontomes are found to be composed of enamel, dentine and cementum, disposed with apparently no definite arrangement.

Signs and symptoms.—An odontome is covered by a capsule from which it derives its nourishment, and during the period of growth gives rise to no painful symptoms, so that its presence often passes unnoticed. Composite odontomes, like teeth, seem to pass through an eruptive stage. The capsule is at some point destroyed, suppuration takes place so that the odontome is likely to be mistaken for a more serious disease of the jaw.

[1] "Tumours, Innocent and Malignant," Second Edition, p. 61.

CHAPTER XVII.

The Treatment of Caries in Children.

THERE are a few points in the treatment of caries and its sequelæ in children that may conveniently be considered at this point.

Too much stress cannot be laid upon the importance of regular and thorough attention to the teeth of children. Dental supervision should commence as soon as the deciduous dentition is complete, and the child should be brought at least three times a year for examination. Cavities can then be filled while quite small, with the result that the teeth can more easily be saved and the operation rendered practically painless—a point of no small importance in dealing with children.

In no part of the work of the dental surgeon is more tact required than in the treatment of children; some possess the gift of readily winning the confidence of the young, but this power is not given to all. The operator must constantly bear in mind that children are but children and are interested only in simple topics. Every effort should be made to interest them and to avoid hurting them, and under no circumstances should they be misled or deceived.

Small crown cavities should be filled with amalgam, palladium being probably best. In approximal cavities amalgam should also be used. Approximal cavities, when opened up and the caries removed, are usually cup-shaped and the retentive shaping must therefore be carried out by grooving. If the tooth is sensitive it is sometimes judicious to bring the filling of amalgam against the approximal tooth, converting as it were the cavity into a simple one.

If the pulp is exposed and the roots are still intact, a small quantity of arsenious acid (about $\frac{1}{50}$ grain) should be employed to devitalise the pulp. The dressing should never remain in more than twenty-four hours, indeed, it is a safe course to apply the

dressing in the morning and remove it in the afternoon. The pulp should then be removed from the coronal portion of the pulp cavity, and if possible from the root canals. Sterilisation should then be carried out and the pulp chamber filled with iodoform or loretin. No attempt should be made to fill the canals, the cavity in the tooth being completed with amalgam.

If the pulp is exposed and absorption of the roots has commenced, the tooth should as a rule be removed. If, however, it is important that the tooth should be saved as long as possible, either to prevent irregularity or for the purpose of mastication, an attempt should be made to save the pulp by "capping."

If the pulp is septic the canals should be cleansed of all *débris* and the canals and pulp chamber thoroughly sterilised and dried. The pulp chamber should then be filled with iodoform or loretin, the canals left alone, and the cavity filled. Rhizodontrophy (drilling a small hole from the outside of the tooth into the pulp cavity) should not be adopted. Septic teeth which cannot be properly treated as outlined above must be removed. The disadvantages arising from early removal of the deciduous teeth are far outweighed by the local and general disturbances which may arise from the absorption of septic matter. The caries of a superficial but extensive character which is occasionally met with is best treated as follows:—The surfaces of the teeth should be freed of loose matter and treated with nitrate of silver. To apply the drug, a small piece should be melted on the end of a steel instrument so as to form a small bead, the nitrate of silver can then be applied to any place with accuracy and safety. About four applications should be made at intervals of about one week, and afterwards regularly at periods of three months. Once a day spirits of wine should be applied to the teeth as follows:—the surfaces of the teeth are thoroughly dried, the spirit applied on cotton wool and the saliva kept away, if possible, for one or two minutes. The spirit, in evaporating, dehydrates the dentine and apparently hardens the surface. Twice a day, morning and evening, an alkaline mouth-wash should be used. If the directions above given are faithfully carried out the teeth can often be retained for the normal period.

Nitrate of silver must be applied with caution, and on no account should it be held between the blades of conveying forceps, because it may slip from them and pass either into the larynx (as is known to have happened in one case) or into the stomach. In the first

case inversion might be tried, but skilled surgical aid should immediately be sought; in the second a plentiful supply of common salt should be given, as this will cause a chemical reaction leading to the formation of the insoluble and inert chloride of silver.

Pulpless deciduous teeth should be removed as soon as their permanent successors show signs of erupting. Pulpless teeth are absorbed slowly and the erupting teeth are therefore liable to be deflected from their course. This can be obviated by timely removal of the deciduous teeth.

The practitioners should impress on parents that the first permanent molars form the vanguard of the second dentition, and direct their attention to the necessity of keeping these teeth scrupulously clean during eruption, as during this period the destructive agents are most active, the loose flap of gum overlying the crown acting as a food trap.

As soon as the first permanent molar shows signs of caries in the fissures on the occluding surface, the fissure should be cut out as thoroughly as the patient will permit and filled with amalgam.

The removal of the deciduous teeth by extraction is dealt with in chapter XX.

CHAPTER XVIII.

Odontalgia and Neuralgia.

Some diversity of opinion exists amongst practitioners as to the precise condition which should be conveyed by the term "neuralgia." It seems advisable to allow the term to embrace pain in the course of a nerve, or within its area of distribution. Pain is only a symptom of a pathological condition, which may or may not be recognisable, in other words, pain and neuralgia are synonymous expressions. The term "trigeminal neuralgia," therefore, should embrace pain in the course of distribution of the fifth nerve.

ODONTALGIA.

The term **odontalgia** may be used, for convenience of description, to indicate pain in or around teeth. Odontalgia, in other words, is neuralgia in the dental branches of the fifth nerve. Irritation of a nerve in any part of its course may cause pain in any other part of that nerve or its connections. The fifth nerve is intimately connected with both the glosso-pharyngeal and the vagus, and the vagus is connected with the abdominal and pelvic viscera. This intimate connection enables us to account for cases of morbid conditions of the pregnant and non-pregnant uterus causing pain in and around teeth.

Odontalgia may be divided into :—

(A) local.

(B) referred.

By local odontalgia is meant pain in or around teeth which are themselves the cause of the trouble; by referred odontalgia is connoted pain in a tooth which is not itself the seat of the cause.

(A) LOCAL ODONTALGIA.

Nearly all morbid conditions of the teeth may be cited as causes of local odontalgia. For convenience they will be grouped under :—

(*a*) Morbid conditions of the periodontal membrane.

(*b*) Morbid conditions of the pulp.

The principal affections under the first head are acute and chronic periodontitis and its terminations, and under the second, hyperæmia, acute and chronic pulpitis. Local odontalgia may be acute or chronic, and for practical purposes the source may be regarded as either the pulp or the periodontal membrane.

(1) **Acute local odontalgia** is generally due to either acute pulpitis or periodontitis. **If due to pulpitis,** the pain will be of a sharp, shooting, throbbing character, more severe when the patient assumes the horizontal position, and greater at night than in the morning. Paroxysms of pain will also be caused by alterations of temperature. A small pledget of cotton-wool placed in the cavity and gently pressed upon with a blunt instrument will generally produce pain, as in this form of odontalgia the pulp is usually exposed. In a few cases the application of cold brings relief, while heat intensifies the pain ; a condition of this character points to a suppurating pulpitis, the cold constricting the arteries and so reducing the blood pressure, the heat dilating the vessels and therefore increasing it. A sharp shooting pain, associated with marked tenderness of the tooth to pressure, usually indicates tension in the pulp chamber from a putrescent pulp.

If periodontal inflammation is the cause, the pain will be found to be of a dull, gnawing, constant character. Percussion of the tooth with an instrument will generally cause pain in cases connected with the pulp ; as a rule pain is not caused by percussion. Pressure with the finger upon the crown of the tooth will also produce pain, and the alveolus is usually tender. A pledget of cotton-wool introduced into the cavity, if one exists, will not give rise to any pain except that which is caused by the pressure transmitted to the periodontal membrane. Alternation of temperature from hot and cold fluids may affect the pain, but not to the same extent as in pulpitis. By limiting the heat or cold to the tooth the source of pain can be easily diagnosed. In periodontitis pain will not be felt.

The **treatment of acute local odontalgia** depends upon the cause. The remedy for each morbid condition has already been dealt with in previous chapters. Temporary relief of the pain in cases of pulp trouble may be obtained by applying to the cavity, on a piece of cotton-wool, some sedative, such as oils of cloves, cinnamon,

peppermint or carbolic acid, covering over the drug with some loose dressing, such as cotton-wool dipped in gum sandarac or mastic. Periodontal pain can generally be relieved by scarification, or an application of liniment of iodine, to which some tincture of aconite may be added. When the pain is due to tension in the pulp cavity from a putrescent pulp, relief can be obtained by opening the pulp chamber and so giving exit to its contents.

(2) **Chronic local odontalgia.**—The **causes,** like those of the acute form, may either be connected with the pulp or with the periodontal membrane. **The symptoms arising from the pulp** will be pain at irregular intervals, but less intense than in the acute form, with a tendency for the pain to wander and follow the course of the nerve.

Alterations of temperature, or the application of irritant food substances, such as sweets, sours, &c., generally produce a paroxysm of pain, which may pass away at once or continue for some time. When the odontalgia arises **from the periodontal membrane** the patient will complain of a grumbling sensation in the tooth and tenderness on pressure. The gum over the alveolus will be slightly swollen, congested and tender to pressure. The pain is usually constant, not paroxysmal, like the pain arising from pulp trouble, but it may be affected by alternations of temperature. A frequent cause of local odontalgia, and one that is often overlooked, is absorption of the septa between the teeth in chronic periodontitis (see page 432). Food collects in the space formed, and pain results owing to pulp irritation *viâ* the cemental tissue.

The **treatment,** as in the acute form, depends upon the cause, and the remedy for each condition has been dealt with in chapters X. and XII.

(B) REFERRED ODONTALGIA.

Referred odontalgia may arise from many causes, and these can be classified as follows:—

(1) Peripheral.
(2) Central or cerebral.
(3) Systemic or general.

(1) **Peripheral.**—Any conditions which give rise to irritation of the terminal portions of the fifth nerve and its connections may cause reflex odontalgia, and by far the commonest condition which

comes under this heading is that which is **dental in origin,** *i.e.*, where the cause lies in a tooth which is not itself the seat of pain.

Such cases are of constant occurrence; a patient complains of pain, say, in a mandibular molar, which, on examination, is found to be free from disease, the cause eventually being discovered in perhaps a maxillary tooth. This condition, generally called referred toothache, is at times so pronounced that manipulation of the offending tooth will cause paroxysms of pain in the sound one, and in one case within the author's recollection the application of arsenic to the pulp caused pain in the sound tooth during the process of devitalisation. Pain may be referred from a maxillary to a mandibular tooth or the reverse; it may also be referred from one tooth to another on the same side of the same jaw. Perhaps the most common and most instructive example of referred pain is that of a mandibular third molar causing symptoms in a mandibular premolar. Pain is never referred across the median line of the mouth. **Morbid conditions of the periosteum of the jaws, and ulcerations of the mucous membrane,** &c., may act as causes of odontalgia, and likewise **operations upon or morbid conditions of the eye and nose.** Cases supporting the latter statement are quoted by Galezowski and Macnaughton-Jones.

The last group of conditions to be recorded under this heading are those arising from **distant viscera.** It is a fact well recognised by most gynæcological practitioners that morbid conditions of the pregnant or non-pregnant uterus may cause odontalgia. In addition to uterine troubles cases of disorders of the alimentary tract, passage of biliary and renal calculi are recorded as leading to distinct odontalgia.

(2) **Cerebral or central origin.** A few cases of odontalgia pointing to a cerebral origin have been recorded, and in one case under the care of Dr. Benson (*Brit. Jour. Dental Science*, Aug., 1867) pain in a first maxillary right molar was apparently due to a **cerebral abscess** in connection with the fifth nerve. Odontalgia may be in some cases a manifestation of **hysteria.** A case of this character was reported by Mr. Morton Smale in the *British Medical Journal*, 1880, vol. i., p. 362. The patient complained of pain in a first mandibular containing a carious cavity. The cavity was dressed but the tenderness of the tooth and the pain continued

despite all treatment. Suspicion of hysteria was aroused, and on pretending to tap a maxillary tooth with an instrument, the one complained of was touched, with no resulting pain, this being performed several times with the same result.

(3) **Systemic or general origin. Malaria, gout, rheumatism, and syphilis** may cause odontalgia, but in the majority of cases they act simply as predisposing causes. People inhabiting malarial districts are certainly liable to distinct periodic attacks of odontalgia, which are only relieved by quinine and similar remedies. **The diagnosis of referred odontalgia** cannot always be readily arrived at. If, after examining a tooth or teeth to which the pain is referred by the patient, no local cause can be found for it, then a systematic examination must be carried out.

As this examination is practically similar to the method to be pursued for investigating cases of neuralgia, it will be considered under that heading.

NEURALGIA.

Neuralgia means pain in the course of the nerve or the area of its distribution. When occurring in connection with the fifth nerve it is known as trigeminal or trifacial neuralgia. As pointed out above neuralgia is to be regarded as a symptom.

(A) CAUSES.

The **causes** of trigeminal pain are :—

(1) Peripheral (due to irritation of the terminal parts of the fifth nerve or any of its terminations), which may be sub-divided into :—

- (*a*) morbid conditions of the pulp.
- (*b*) morbid conditions of the periodontal membrane.
- (*c*) morbid conditions of the gum and mucous membrane of the mouth, nose, &c.
- (*d*) morbid conditions of remote parts, such as the uterus.

(2) Causes affecting the nerve in its passage from the brain to its terminations, including—

- (*a*) injuries from contusion and lacerations.
- (*b*) pressure from impaction of mandibular third molar teeth, periostitis of the bony canals, and presence of tumours.
- (*c*) inflammation of the nerve in syphilitic gummata, carcinomatous and other tumours and inflammation.

(3) Cerebral or central causes, such as sclerosis and other degenerative affections of the nervous centres.

(4) Constitutional. Malaria, anæmia and hysteria.

(5) Many cases are apparently idiopathic.

(B) CHARACTERS OF TRIGEMINAL PAIN.

When arising from peripheral irritation the pain is usually of a boring, shooting, burning character and is nearly always paroxysmal in form. It is located in most cases to a certain area of the face. Palpation over the affected area will reveal the presence of tender spots which are usually situated at the exit of the nerve from a bony foramen. In more severe conditions the pain is accompanied by severe convulsions of the facial muscles. In the form known as **tic epileptiform** the attacks are very frequent and are started by the slightest occurrence, such as slamming a door, or a draught of air, until the patient's life becomes unbearable. A very full and excellent account of neuralgia will be found in Dr. Head's article, (Allbutt's "System of Medicine," vol. vi., p. 743).

Dr. Head has endeavoured to show that visceral disturbances often produce pain at certain points on the surface of the body, the pain frequently being accompanied by more or less definite areas of superficial tenderness. These areas are designated by the term "segmental." The exact relationship of each tooth to the segmental areas seems to vary. The following table is given by Dr. Head.

Approximate :—

Maxilla.		Mandible.	
Incisors ..	.. Front nasal	Incisors ..	.. Mental
Canine ..	.. Naso-labial	Canine ..	.. ,,
Premolar I.	.. ,,	Premolar I.	.. ,,
,, II.	.. Temporal or maxillary	,, II.	.. Doubtful
Molar I. ..	.. Maxillary	Molar I. ..	.. Hyoid
,, II. ..	.. Mandibular	,, II. ..	.. ,,
,, III. ..	.. ,,	,, III. ..	.. Superior laryngeal or hyoid

The figures on next page show these areas, and the maximum points of these areas.

The method of testing for the superficial tenderness is by means of the blunt end of a pin. To the normal skin the touch feels blunt, but when the skin is sensitive the patient complains that the touch

hurts, and that the part is tender, or he may think he is being pricked. The tender area over the hairy scalp may be defined by gently pulling the hair, while with skin overlying soft structures, such as the neck, gentle pulling between the fingers is advised.

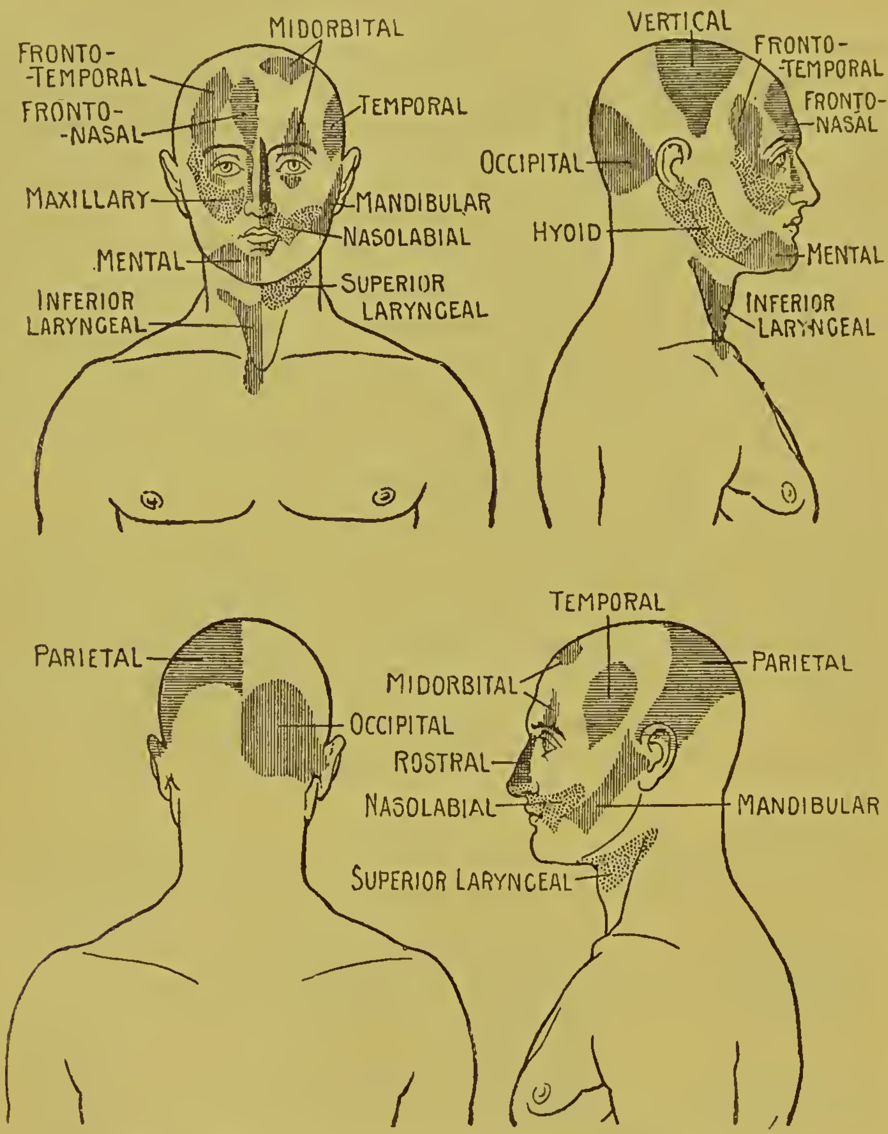

FIG. 578.—From Allbutt's "System of Medicine."

Dr. Head's observations are interesting, but further investigations are required before their practical value in diagnosis can be definitely determined. The "segmental" areas are not to be confounded with the so-called "foci" of pain observable in certain neuralgias.

(C) DIAGNOSIS.

The diagnosis of the cause of facial neuralgia is important on account of the treatment, and all cases coming under notice should be subjected to a systematic examination. The patient should be questioned as to the character of the pain to discover whether it arises from the pulp or from the periosteum. It is also important to ascertain if the pain is periodic, while at the same time the situation of the pain is important as it assists in localising the position of the tooth should the neuralgia be of dental origin. Thus pain in the infra-orbital or supra-orbital region points to maxillary teeth; pain in the ear, shooting down the shoulder, points to mandibular teeth; while pain over the parietal eminence indicates trouble from either maxillary or mandibular teeth. Next, the teeth must be examined for carious cavities, and should any be found, a search should be instituted to discover if any chronically-inflamed pulps exist. This examination should be carried out with a mirror and a probe, care being taken to look for approximal cavities near the gum margin. After this, periodontal causes should be excluded by pressing and tapping the teeth. Irritability of the pulp through pathological changes must next be eliminated by looking for exposed surfaces of dentine or cementum. Exposure of the root in local suppurative periodontitis is a fruitful cause of neuralgia (see p. 432). Each tooth should next be tested with heat and cold, and in doing this attention should be bestowed upon teeth containing large metal fillings. In testing with heat, a steel burnisher should be made hot and applied to each tooth separately; while the test with cold is easily carried out by touching each tooth with a small pledget of cotton-wool dipped in ice-cold water. If a jet of cold water is used from a syringe, the water will run over two or three teeth at a time, and so prevent ready detection of the offending tooth. It must not be forgotten that most teeth with live pulps, if submitted to the above treatment, will respond to the changes; but when the pulps are healthy, the condition will be quite transient, while if diseased, the test will probably set up an acute paroxysm of pain. In cases of doubt the approximal ones should be tested as well as the suspected ones.

The pain started in the affected tooth will be greater in comparison to that in the approximal ones. General suppurative forms of periodontitis are to be regarded as frequent causes of trigeminal

pain. The exposure of the roots leads to irritability of the pulps from thermal and other irritations, while in advanced conditions the pulps may be affected *viâ* the apical foramen by spread of inflammation from the periodontal membrane.

If a cause has not been discovered by the above-mentioned examination, the absence of third molar teeth, a frequent cause of neuralgia in those between 18 and 30, should be investigated. Such causes as morbid conditions of the periosteum of the bony canals through which the nerve passes, peripheral irritation in other parts of the distribution of the fifth nerve, and pregnancy, must next be excluded. Failing these, the presence of antral mischief or tumours in the region of the trunks of the nerve should be looked for, and then the question as to degenerations of the nerves themselves or their origins in the brain considered. The diagnosis of these belongs to general medicine.

(D) TREATMENT.

If the neuralgia is dental in origin the cause must be removed by measures indicated for the treatment of such lesions. When the cause is constitutional, remedies appropriate to the condition must be adopted. For instance, if arising in connection with general debility, anæmia, or overwork, a general tonic treatment with such drugs as iron, quinine, and arsenic will be beneficial, careful attention being paid to the condition of the bowels. Phenacetin (10 to 15 grains) one of the antipyrin group, is useful in neuralgias of peripheral origin. If of malarial origin, quinine in large doses, *i.e.*, grains v., will bring immediate relief, and if given before an attack will, in some cases, ward it off, and in others greatly minimise its severity. Should there be any suspicion of syphilis iodide of potassium will be indicated; while with gout and rheumatism the same drug may prove useful. In addition to the internal administration of drugs, local applications may be tried, such as chloral and camphor, in equal parts, aconite and chloroform, or counter-irritants, such as cantharides, capsicum and mustard. In more severe cases, electricity, the injection of cocaine or morphia, may be resorted to. If no cause can be found, and the above treatments fail, the drugs which may be termed "neuralgic specifics" should be tried, amongst these being tinct. gelsemini (8-15 ♏), veratrina ($\frac{1}{70}$-$\frac{1}{16}$ gr.), butyl chloral hydras (2-15 gr.). In

combination with these such drugs as dilute hydrobromic acid, chloral and bromide of potassium may be given.

In cases where treatment by drugs fails, the patient continuing in great pain, surgical measures may be adopted. These questions belong to the domain of general rather than dental surgery.

CHAPTER XIX.

Affections Arising from the Presence of Diseased Teeth.

In a previous chapter an endeavour was made to show how any irritation of portions of the fifth nerve or its connections may give rise to odontalgia; in this chapter it is proposed to deal with conditions which at times are traceable to diseased teeth. Considerable difficulty has been experienced in dealing with this subject owing to the comparative scarcity of cases recorded with sufficient accuracy and detail to be of any real service. Of the recorded cases many are incompletely described, and in a large number the diseases are capable of explanations other than those offered by the observers.

Too great an anxiety to establish a far-reaching influence to the teeth has, it is feared, often led to hasty and fallacious diagnoses, diseases which are merely coincident being wrongly associated in a causal relationship. Cases of disease which are thought to be dependent upon dental trouble should be thoroughly investigated, and should only be reported when a distinct relationship can be conclusively proved and any other possible cause has been eliminated.

The affections traceable to dental lesions may arise either :—

(1) Through reflex irritation.

(2) Through direct pathological sequence.

(3) Through the absorption of septic or infective material.

For convenience of description the various affections will be considered in groups.

(A) AFFECTIONS OF THE CEREBRAL CENTRES.

(1) **Epilepsy** and convulsive seizures would appear to occasionally arise from dental irritation, and cases illustrative of this have been

recorded by Coleman,[1] Portal,[2] Tomes,[3] Ramskill[4] and others. One related by Ramskill is very interesting :—[5]

"A boy, aged 13, has had frequent attacks of epilepsy for the last eighteen months. Latterly his mother has noticed that some days he rubs his left cheek, complaining of faceache, after which the fit follows. On examining the mouth there is to be seen a molar tooth considerably decayed, with a swollen gum around it and partly growing into the cavity; it is not very tender to the touch and the examination does not give rise to toothache. On questioning, I find the sensation which the boy experiences before a fit does not seem to be one of pain, but rather of an indefinite uneasiness. He always has a fit the night this comes on. Has never felt it during the day; it is always about seven or eight o'clock. I desired the mother to have the tooth extracted and ordered a simple saline with a quarter of a grain of belladonna to be taken twice daily. This was in June. The tooth was extracted next day. I saw this boy once a fortnight from that time for four months, but he has had no recurrence of the fit. In this case I believe an unfelt aura commenced about the gum surrounding the tooth and was not recognised till some degree of inflammation arose, thus a modification of pain became associated with the aura and directed attention to it."

That epilepsy may be caused by dental as by any other peripheral irritation is quite possible. Dr. Brown Séquard found that after section of one of the lateral columns of the cord anywhere between the medulla and tenth dorsal vertebra epilepsy could be produced by very slight irritation of the fifth nerve. A case of some interest also came under the observation of Mr. Morton Smale :—

"A patient, aged 22, a male, always showed distinct signs of *petit mal* during the operation of filling, the symptoms being always more marked if an exposed nerve were touched. This patient, to the best of his recollection, had never suffered at any time with epilepsy or had had fits of any other character."

(2) Hysteria.—Cases of hysteria supposed to arise from dental irritation have been recorded. Hysteria is such an obscure and, in some respects, mysterious condition that it is quite conceivable that continued pain from dental trouble might set up hysteria in a patient so predisposed.

(3) Chorea.—Some medical writers are of opinion that chorea may in some instances be connected with dental irritation. Chorea

[1] *British Journal of Dental Science*, 1863.

[2] Portal's *Observations sur l'Epilepsie*, p. 333.

[3] Tomes, "Dental Surgery," 4th edition, p. 567.

[4] *Medical Times and Gazette*, 1862, vol. ii., p. 216.

[5] The cases recorded under this and subsequent headings have been introduced in order that the student may gain some idea of the evidence on which the relationship between dental and other diseases is based.

is a functional condition and it is quite possible that the dental lesion may either directly by reflex irritation, or indirectly by lowering the vitality, induce chorea. The following case, quoted in the "American System of Dentistry,"[1] would seem to indicate that the dental trouble was intimately connected with the choreic condition. The case is related by Dr. C. N. Pierce :—

"A boy, aged 9, had always been in good health until two years ago, when he was attacked with choreic movements chiefly in the muscles of the face, though present also in the muscles of the neck and shoulders. Owing to their local character, and the absence of the causes usually assigned for the appearance of chorea, it was thought possible that the condition of the teeth might offer some explanation of the trouble. Careful examination of the mouth revealed, in additon to considerable overcrowding of the teeth, persistence of the deciduous incisors. Upon their removal the choreic movements at once subsided. After an interval of a year there was a return of the symptoms. Examination of the teeth again showed a persistence of the deciduous molars delaying the eruption of the premolars. Removal of the offending teeth was followed by complete recovery."

(B) AFFECTIONS OF THE MUSCULAR SYSTEM.

(1) **Facial paralysis** is found at times associated with dental irritation, and in reading the history of some of the recorded cases the trouble from the teeth would appear to have played a prominent part in the causation of the paralysis. Interesting records are given by Poundall,[2] Garretson[3] and Salter,[4] while Gabriel[5] reports a case where facial paralysis was apparently the result of extraction.

"The patient, a healthy well-made man, had the roots of the left second and third mandibular molars extracted at 12 noon, and on recovering stated that his right cheek felt stiff, which may or may not have been due to the gag. At 3 p.m. the same day a maxillary molar and the right maxillary and mandibular first molar roots were removed, and after recovery there was inability to close the right eye, with other symptoms of paralysis. The patient eventually recovered."

In several of the cases recorded the paralysis was due to implication of the facial nerve by direct extension of inflammation from the teeth. Such a case is recorded by Salter.[4]

How these reflex paralyses (if such they be) are produced is

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[1] Vol. iii., p. 498.
[2] *British Journal of Dental Science*, 1879, p. 56.
[3] "Oral Surgery."
[4] "Dental Pathology and Surgery," p. 271.
[5] *British Journal of Dental Science*, 1885, p. 359.

doubtful; but it must be remembered that the facial nerve is connected with three of the ganglia in connection with the fifth nerve, namely, with Meckel's by the greater superficial petrosal nerve, with the otic by the lesser superficial petrosal, and with the submaxillary through the chorda tympani. A careful examination of the teeth should be made in cases of facial paralysis, but care must be taken not to sacrifice teeth needlessly.

(2) **Histrionic spasm** (spasm of the facial muscles).—The record of a case of spasm of the facial muscles, apparently due to dental irritation, is published in the *Dental Record*, 1900.

"The patient was a man aged 36. Two years previous to being seen he had suffered from slight occasional clonic spasms of the upper part of the right side of the face. A year after the onset, while journeying to London by steamer in warm weather, he had several fairly severe attacks affecting the right orbicularis palpebrarum. The twitchings increased in frequency and severity, gradually affecting the right half of the frontalis, the muscles about the angles of the mouth and the ala of the nose. He complained of slight discomfort in the right maxillary and mandibular teeth, but no distinct pain. Changes of weather did not affect the spasms. There was no history of rheumatism and no specific history. The patient was a heavy smoker. There was no history of ear disease, headache or vomiting. Electrical examination of the facial muscles showed those on the left side to be much less excitable, and their contraction less powerful than those on the right. The conjunctival reflex was markedly impaired on the right side, but the sensation caused by touching the conjunctiva was the same on both sides. An examination of the mouth showed the gums to be congested owing to the deposit of calculus, the congestion being more marked on the right side than on the left. The teeth were in a neglected condition, the right side of the mouth in this respect being much worse than the left. General treatment had been tried for nearly one year. Local treatment was then tried, all roots and teeth with septic pulps being removed and the others filled. The calculus was removed and the gums treated. The dental treatment lasted three weeks, during which time improvement occurred, the patient eventually making, as far as could be ascertained, a complete recovery."

(3) **Paralysis of the arm.**—In the chapter on odontalgia reference was made to the occurrence of pain in the arm which was traceable to the teeth. It is interesting to note that cases of supposed paralysis of the arm have been recorded as due to dental lesions. Salter[1] records the following:—

"Miss B., aged 24, consulted me on October 15, 1864, respecting the left lower wisdom tooth, and the symptoms to which it had apparently given rise. The tooth had pierced the gum, but it was low down and placed horizontally, the crown pressing forwards against the second molar. The tooth was carious.

[1] "Dental Surgery and Pathology," p. 264.

From the first attempt at the eruption of this tooth there had been much pain of the ordinary kind about the angle of the jaw; latterly it had been intense, and for a fortnight there had been paralysis of the left arm; the patient complained of total inability to use the arm, to raise it or grasp with the hand; she could not employ the limb in dressing herself, and could not hold her fork at dinner. There was also a continuous pain of the whole arm resembling rheumatism. I extracted the tooth, but with extreme difficulty. As soon as the patient recovered from the pain of the operation she declared that the arm symptoms had vanished completely."

In this case, as in many similar records, no electrical examination of the muscles is recorded. Before arriving at a diagnosis of paralysis it would always be well to exclude hysteria, and to carefully ascertain that the case is not one where the part is involuntarily kept inactive in order to avoid pain.

(4) **Spasm of the sterno-mastoid**—Wry-neck. A case of spasm of the sterno-mastoid has been recorded by Hancock.[1] This patient, a woman, had suffered considerable pain in the left shoulder apparently due to a carious tooth on the left side of the mandible. The head was drawn down nearly to the left shoulder. On removal of the tooth the condition disappeared. In this case, as in others recorded, there was probably no true spasm of the sterno-mastoid, the head being placed involuntarily in the bent position as a result of the pain.

(5) **Spasmodic closure of the jaws.**—A case of tetanus occurring simultaneously with the extraction of a tooth is given in Wedl.[2] True tetanus is now known to be due to an infective micro-organism. It is probable therefore that this was not a case of true traumatic tetanus, but rather an example of tetanoid symptoms due to reflex irritation. Such conditions are occasionally met with, as the following case reported by Dr. Ewart[3] will show.

"The patient, a man aged 47 years, moderately addicted to alcohol, was suffering from an extensive chronic ulcer of the right leg. His illness began with a 'severe cold' three weeks before his admission into St. George's Hospital on September 20, 1899. The trismus set in quite suddenly during the night a week later, when he awoke in a fit of suffocation due to the closure of his lips unsupported by teeth. The same nocturnal attacks continued to occur in the hospital for five weeks. The rigidity of the jaws, of the floor of the mouth, of the platysma of the neck, and of the abdominal muscles was intensified by excitement, but there was neither opisthotonos nor any spasm of the limbs.

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[1] *Lancet*, 1859, vol. i, p. 80.

[2] "The Pathology of the Teeth," p. 346. English Edition.

[3] *Brit. Journ. Dent. Science*, January 11, 1900.

Speech, respiration and alimentation were much impeded, leading to loss of flesh and weakness. There was a tender and slightly swollen spot on the gum, and the case was diagnosed from the first as one of reflex spasm due to periosteal irritation and tenderness at the left posterior extremity of the upper jaw, and local treatment was recommended. This was finally resorted to, after various remedies had proved ineffectual, at the end of October, and the symptoms rapidly disappeared after the tender gum had been freely incised."

This case was probably purely reflex, the absolutely edentulous and healthy condition of the gums excluding the theory that septic infection from the mouth was the cause.

Many cases of so-called trismus arising from the teeth are not due to spasm of the masseter muscle as usually supposed. The closure of the jaw in most cases arises from infiltration of the muscles and tissues around, the interference with the movement of the jaw being due partly to mechanical impediment from the inflammatory products and partly to involuntary closing of the jaw on the part of the patient.

(6) **Hemiplegia,**[1] **paraplegia,**[2] **and even general paralysis**[3] of supposed dental origin have been recorded, but a careful perusal of some of the cases would point to hysteria as the cause. It is extremely difficult to conceive such diseases arising from reflex dental irritation.

(C) MISCELLANEOUS AFFECTIONS.

(1) **Cardiac irregularity.**—In the Lumleian Lecture, 1899, Sir Douglas Powell records a case of this character.

"The patient, a married woman aged 36, had for two years suffered from excessive cardiac irregularity and frequent attacks of spasmodic heart pains. She attributed her illness to much previous mental anxiety. Her symptoms had increased the last few months and the cardiac disturbance became so constant that she could neither go into society nor receive friends. There was no valvular disease of the heart and its dimensions were normal, but the action was most irregular and intermittent. Her teeth were extensively decayed, surrounded with tartar, and the gums were unhealthy. She had declined to have them seen to, however, and she was put through a course of Nauheim baths and resistance exercises, and her digestion attended to, with only slight relief. After the consultation she consented to have her affected teeth removed under gas and ether, which she took well, and from that time her cardiac symptoms have entirely ceased, although she has been exposed to even greater nerve-strain than

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[1] Suessorott, *Dental Cosmos*, November, 1868.
[2] Corbett, *Trans. of International Med. Congress*, 1881, p. 476.
[3] Levison, *Lancet*, 1851.

before. In this case there were no marked dyspeptic signs and the cardiac symptoms seemed to be due chiefly to the reflected irritation of the decayed teeth."

(2) **Leucorrhœa.** — Sercombe[1] has recorded a case in which uterine pain and leucorrhœa were due to dental irritation. Touching the tooth with a probe caused a paroxysm of pain. The pain and the leucorrhœa were both cured by the removal of the tooth.

(3) **A furred condition of the tongue** on the same side as an irritable tooth is frequently to be observed. This may be regarded as an example of disordered nutrition from the dental irritation.

(D) AFFECTIONS OF THE NOSE.

The nasal cavity may become affected from the teeth by direct pathological sequence. Cases of nasal disease attributable to reflex dental irritation are excessively rare. A case of coryza apparently of dental origin has been reported by Mr. E. P. Collett.[2]

"The patient, a medical man, had suffered from persistent coryza, mainly unilateral, for three or four weeks. No physical cause could be found except some stigmata on the middle turbinated bone, associated with general vasomotor dilatation of the membrane. A solution of cocaine (4 per cent.) was prescribed together with general treatment. The coryza did not lessen, and neuralgia in the region of the temple, malar bone and, subsequently, behind the right ear supervened. The first maxillary premolar, which showed signs of chronic periodontitis, was removed. There was no suppuration present. By the morning following the removal of the tooth the pain had entirely gone and the coryza disappeared in the course of three days."

(E) AFFECTIONS OF THE EAR.

Some writers seem inclined to regard dental lesions as a prolific cause of aural disorders. For instance, Sexton[3] remarks, in reviewing records of some 1,500 cases, that "Perhaps one-third owe their origin or continuance in a greater or less degree to diseases of the teeth." Mr. Herbert Waterhouse,[4] on the other hand, who has had considerable experience in aural diseases, states that he "can scarcely recollect a single case of aural disease which has been definitely proved to be due to dental irritation." He thinks

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[1] *British Journal of Dental Science*, vol. iii., p. 221.
[2] *Lancet*, Jan., 1897.
[3] *American Journal of Medical Science*, January, 1880.
[4] Private communication.

that neuralgia of the middle and external ear is very frequently due to dental irritation, and in almost all cases the teeth concerned are molars. The nervous connections of the otic and spheno-palatine ganglia explain the frequency of these neuralgic pains.

(1) **Otalgia.**—Neuralgia of the ear, independent of inflammatory symptoms, is often met with in connection with dental lesions, and may be regarded as an instance of *referred odontalgia* (see chapter xviii.).

(2) **Otorrhœa.**—Hilton, in his work on "Rest and Pain," records a case of this character.

"The patient was a medical man who suffered from a persistent purulent discharge from one ear from a slight ulceration for which no cause could be found. Removal of a carious mandibular molar was followed by a complete cure of the aural trouble. In this case it would appear that the reflex irritation had led to interference with the nutritive function of the nerves supplying the external meatus."

(3) **Verruca of the external meatus.**—Dr. Barclay[1] records a case of verruca of the external meatus which was very painful and recurred several times after removal during a year. After removal of some carious teeth on the corresponding side, the verruca was removed and never returned.

(4) **Inflammation of the middle ear.**—The catarrhal and also the purulent form are said to be due at times to dental irritation. In many of the cases recorded, however, the improvement of the ear condition would appear to be due to an improved condition of general health resulting from treatment of the oral condition, the dental irritation in no way being the direct cause of the otitis.

(5) **Deafness.**—Mr. Cattlin[2] describes a case of deafness caused by a dental lesion.

"A lady in the second stage of phthisis consulted him concerning a carious mandibular molar. For about three months she had suffered acute pains in the tooth, ear and side of the neck, and when seen by him had been deaf for four days. The tooth was removed, and within one hour hearing returned."

(F) AFFECTIONS OF THE EYE.[3]

Many ocular affections are attributable to the teeth. They may be classified under two headings: (1) Those arising by direct con-

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[1] *Dental Cosmos*, May, 1894, p. 343.

[2] *Trans. Odonto. Soc. of Great Britain*, vol. iii., p. 308 (old series).

[3] I am indebted to Drs. Griffith and Keeling for kindly revising this section.

tinuity of disease from the teeth to the orbit; (2) Those resulting from reflex irritation.

(1) **Affections arising from direct continuity.**—The transference of disease from the teeth to the orbit and eyeball by direct continuity is mainly, if not exclusively, inflammatory. The inflammation starts in the periodontal membrane and spreads to the orbit *viâ* the antrum. The path of transmission is either through the lymphatic system or by the veins. The inflammatory products in the antrum create a spreading phlebitis in the plexus of the veins situated in the mucous membrane of that cavity. The morbid process enters the orbit either along a direct venous communication through its floor or by means of the facial vein, the facial vein being intimately connected on the one hand by anastomoses with the antral veins, and on the other hand with the orbit, either through the angular vein or by its connection with the pterygoid plexus of veins. The inflammation may spread by a more superficial route through the periosteum of the maxilla.

Orbital periostitis and cellulitis are the most common of the troubles which come under this heading. The inflammation may vary greatly in character and intensity, and may be considerably modified by external influences. A diffuse suppurative cellulitis may be set up, and involve all the contents of the orbit, threatening the life of the patient by meningitis or septic thrombosis of the cavernous sinus. It is probable that orbital periostitis, either alone or attended by cellulitis, occurs as a complication of dental caries more commonly than is generally supposed. A severe case of suppurative orbital cellulitis of dental origin was recorded in the *British Medical Journal* (October 19, 1895) by Messrs. Morton Smale and Juler. The disease may assume a much more insidious form, and may be unattended by proptosis, limited movement, diplopia and the other common manifestations of orbital cellulitis. It may, on the other hand, cause changes in the fundus oculi, viz., papillitis, neuro-retinitis or choroiditis.

Certain cases of **acute retro-bulbar optic neuritis** are probably secondary to orbital cellulitis of dental origin. **Ocular muscular paresis,** involving one or more of the extra-ocular muscles, may arise from the inflammation around the teeth spreading to the orbit. A case of paresis of the orbicularis palpebrarum is reported by Ely, in which the paresis disappeared on the evacuation of a dento-alveolar abscess.

(2) **Diseases resulting from reflex irritation.**—Reflex diseases of the eye from dental irritation, according to many authors, are numerous and varied. A careful study of many of the cases recorded shows that the conclusions arrived at are based on insufficient data.

(*a*) Inflammatory Affections of the Conjunctiva and Cornea of Reflex Origin.

Phlyctenular conjunctivitis or "strumous ophthalmia" attacks not only the bulbar conjunctiva but also the superficial layers of the cornea, ulceration being liable to occur. Carious teeth are frequently present in children with phlyctenular conjunctivitis, and this has led some surgeons to conclude that there is a causal co-relationship between the two diseases, but caries and phlyctenular conjunctivitis are both so frequently met with that their association is probably only a coincidence. In practice, cases of corneal ulceration often remain obstinate to treatment until an irritable tooth is removed, when healing often rapidly follows. Similarly, the removal of any other source of peripheral irritation of the fifth nerve, such as pediculosis of the scalp, will be attended by a speedy healing of a corneal ulcer. The carious tooth does not create the ocular inflammation, but when the inflammation is well established healing may be retarded by the carious tooth. Other forms of keratitis, including the syphilitic interstitial variety, are in like manner often markedly benefited by the removal of carious teeth. **Senile conjunctivitis**, an obstinate and chronic form of inflammation, is often benefited by the removal of a suppurating tooth or by the treatment of a suppurative condition of the gums.

A case of **herpes of the cornea** has been recorded by Hounsell, which, in spite of treatment, persisted for two or three months. On the removal of a troublesome canine tooth, the ulcer rapidly and permanently healed.

Iritis.—It is very doubtful whether plastic iritis or irido-cyclitis can be the outcome of reflex irritation from a tooth. The timely removal, however, of an inflamed tooth will sometimes convert a slowly healing process into a rapid cure. Faucheron[1] and Millikin[2] each report a case of iritis which they attribute to dental irritation.

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[1] *Recueil d'Ophtal.*, 1881, p. 145.

[2] *Arch. Ophth. and Otol.*, New York, March, 1900.

In the one, the iritis was rapidly cured by the extraction of the tooth, in the other, the troublesome eruption of a third molar was the chief agent in producing an iritis which rapidly subsided after the tooth had been attended to.

Lachrymation.—Apart from an emotional flow of tears from the distressing pain of odontalgia, the eyes will occasionally become suffused with tears through sudden pain caused by biting on a sensitive tooth. This is similar to the reflex overflow of tears produced by pungent vapours, *e.g.*, strong ammonia.

Spasm of the orbicularis palpebrarum : blepharospasm.—Excessive blinking is a mild variety of chronic spasms of the orbicular muscle of the eyelids. Knies has seen a case of this kind disappear immediately after the removal of a painful tooth.

Blepharospasm is occasionally traceable to reflex dental irritation, and in such instances can be cured by attention to the teeth. Blepharospasm may, however, occur in elderly people with edentulous jaws. In these cases it is supposed that the osseous sclerosis present causes the spasms reflexly by the imprisonment of filaments of the dental nerve. Such cases are difficult, in fact, almost impossible, to cure. The spasm involves not only the orbicularis palpebrarum, but many of the other muscles supplied by the facial nerve. It varies from slight twitching of the orbicular muscle to a violent spasmodic contortion of the whole side of the face. It is usually asymmetrical, and is seen more often in elderly females. It has no association with *tic convulsif*.

Spasm of Müller's muscle.—Mr. S. J. Hutchinson[1] has recorded a case of spasm of the levator palpebræ superioris reflexly produced by a carious molar tooth. Removal of the tooth cured the spasm. As no other muscles supplied by the third nerve were affected, this was probably a case of spasm of the muscle of Müller, which is supplied by the sympathetic nerve, and not of spasm of the levator palpebræ.

Spasmodic contraction of the internal rectus muscle is manifested by an internal or convergent strabismus. A squint not infrequently develops during the period of the eruption of the deciduous molars, and many mothers assert that the squint is due to the dental irritation. This is true only so far as the disturbance created by the eruption of the teeth acts as the determining cause

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[1] *Transactions of the Odontological Society*, vol. xviii., p. 7.

of the strabismus. The fundamental cause, hypermetropia, being present, any condition which impairs the health of the child and interferes with the disestablishment of convergence (a dissociation which must inevitably take place to avoid a squint) must lead to a convergent strabismus. Convulsions, measles, whooping cough, adenoids, &c., are all in turn credited as the cause, and early dentition is perhaps as common a determining cause as any.

Spasm of accommodation.—Spasmodic contraction of the ciliary muscle, similar to spasm of the internal rectus, seems occasionally to have a reflex dental origin. Attention to the teeth will sometimes cause a chronic ciliary spasm to relax, and a troublesome case of apparent myopia to be cured.

Paresis of the levator palpebræ superioris. — Hancock[1] and Nicol[2] have each recorded a case of ptosis which disappeared after the treatment of carious teeth. In all probability, however, the ptosis in these cases was purely functional.

Paralytic strabismus.—It is impossible for a paralytic squint to be produced reflexly from any source of irritation, though some observers think that they have seen a paralysis of an ocular muscle produced by dental irritation. Such cases are probably due to direct continuity of disease (see page 536).

Muscular insufficiency with diplopia has been attributed to painful carious teeth.

Paresis of accommodation.—Accommodative failure, attended by asthenopia, is recognised by many surgeons as due to diseases of the teeth. Schmidt found it present seventy-two times in ninety-two cases of dental caries. It probably results, as Knies suggests, from the lack of vigorous innervation on account of the distressing pain. On the other hand, Priestley Smith found unimpaired accommodation in fifteen out of sixteen cases of odontalgia.

Amaurosis and amblyopia.—Amaurosis, or complete functional loss of sight, and amblyopia or impaired visual acuity, are two functional conditions which have over and over again been attributed to reflex dental irritation. There are a great number of such cases on record. In some of these there was probably an acute retrobulbar optic neuritis, the result of inflammation by continuity (see page 536). In others the element of hysteria was probably very predominant.

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[1] *Lancet*, 1859, p. 80.
[2] *Trans. Odont. Soc.*, November, 1895.

Galezowski records a case of a lady who suffered from impaired vision upon a tooth being stopped. When the filling was removed her vision improved, but relapsed again when the tooth was re-stopped. The removal of the tooth wrought a permanent cure.

Glaucoma. — In referring to convergent strabismus it was pointed out that the irritation from eruption might in some cases be the determining cause; in like manner it is possible that odontalgia may be the determining cause of a glaucoma. If an eye is anatomically in a condition favourable for the onset of an attack of glaucoma, severe pain arising from a carious tooth may so lower the vitality of the patient that the disease may be started. Von Hippel and Grünhagen[1] consider that irritation of the fifth nerve raises the intraocular pressure. Priestley Smith's[2] experiments, however, seem to show that the tension is not increased in odontalgia.

(G) DISEASES THE RESULT OF SEPTIC ABSORPTION.

In dealing with the diseases of the pulp and periodontal membrane, attention was directed to the suppurative conditions in adjacent tissue which may arise by direct extension from the teeth. Here it is proposed to deal with some of the more obscure pathological conditions which are probably in some instances traceable to septic absorption from diseased teeth.

(1) **Lymphadenitis.**—Inflammation of the lymphatic glands is at times traceable to septic teeth. The glands affected will be those which receive the lymphatics from the regions of the teeth, namely, the parotid group, superficial and deep, which receive the lymphatics from the maxillary teeth, and the sub-maxillary and sterno-mastoid group (superficial) which receive those from the mandible. The lymphadenitis may be acute or chronic. The **acute** is met with usually in connection with acute septic conditions of the teeth, but it may be due to the suppuration of a gland which has been chronically enlarged.

Chronic lymphadenitis is more frequently met with, and is important because such glands frequently become the seat of tubercle. Odenthal of Bonn has published the statistics of 987 children he

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[1] *Arch. für Ophth.*, xiv., i., p. 107.

[2] Priestley Smith, "Glaucoma," London, 1879.

examined. He found in 28·6 per cent. no carious teeth and no gland enlargement. In 70·7 per cent. glandular enlargements were present, carious teeth being associated with the glands in more than half of the cases. Only five cases showed carious teeth without glandular swellings. Odenthal found that when caries existed on both sides glandular enlargements were also present on both sides. Hoppe of Leipsic has also investigated the subject. His figures clearly demonstrate the association of the glandular swellings with carious teeth, but his percentages differ. He finds in 269 cases the absence of carious teeth and glandular swellings in only 4·4 per cent. In 73·9 per cent. glandular swellings were present, and in nearly all instances associated with carious teeth. The number of children with carious teeth but without glandular swellings was 21·5 per cent. The fact that carious teeth are so frequently associated with chronic lymphadenitis by no means indicates that the glandular trouble is directly traceable to the teeth. The tonsil is probably a far more frequent source of infection. That the bacilli in the case of tuberculous glands may gain an entrance by the teeth is shown by two cases recorded by Starck.[1] In one the patient, a boy aged 18, who had always been healthy, developed tuberculous glands. Carious molars were present on both sides. The glands were removed and the teeth extracted. The glands on examination were proved to be tuberculous, and cover-slip preparations from the carious teeth showed the tubercle bacillus. From the experiments of Halle of Berlin it seems possible that the bacillus may gain entrance at times through the living pulp. This author laid bare the pulp of a tooth in a dog, and covered it with Prussian blue and closed the cavity with cement. The dog was killed after two or three days, and the pulp of the tooth, as well as the submaxillary glands, examined with the microscope. Particles of the Prussian blue were found dispersed throughout the pulp up to the apex of the root, and also in the glands, although in very small quantities. The clinical investigations of Halle also support the theory that the bacillus may gain an entrance through the living pulp, for in the teeth considered responsible for the glandular enlargements more than half had living pulps.

(2) **Remote and general affections.**—During the past few years the possibility of general affections being traceable to infection

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[1] *Revue de la Tuberculose*, July, 1896.

from the mouth has attracted the attention of the medical profession. When one considers the amount of pus which is swallowed when such conditions as suppurative periodontitis exist, it is not surprising that it should give rise to infection in remote parts. At present the question is in its infancy, but with more careful observations it is more than possible that the infective nature of many of those obscure conditions, such as osteo-myelitis, suppurative meningitis, ulcerative endocarditis, and acute nephritis, will in some instances be shown to be traceable to the teeth. In a paper communicated to the Royal Medical and Chirurgical Society, 1900, Mr. Rickman Godlee drew attention to some cases coming within the domain of the medical practitioners which were apparently due to suppuration in the mouth. They are sufficiently instructive to deserve quotation.

"The first was that of a lady about 40 years of age. There was an offensive red expectoration, from which she had suffered for years. There was a long history of previous diseases dating back to 1881. They included a miscarriage, a bad confinement, uterine misplacements, vaginal discharge, and a floating kidney, shivering fits and headaches, and five or six attacks of influenza with chest and bronchial troubles. In 1886 she was said to have had congestion of the lung or lungs, and she had had more or less pain, especially on the right side, since 1882. The expectoration began in the autumn of 1897, and consisted of 'lumps of green and yellow stuff.' In December, 1897, the expectoration became bloody, and continued so until I saw her in December, 1898. She said that she had spat up blood and lumps of matter.

"There were practically no physical signs in the chest, except 'slight retraction at the right posterior base with lessened movement, some increased resistance on percussion, and weak breath sounds.' Her principal complaint was that she had this extremely offensive expectoration, amounting to five or six ounces in the twenty-four hours. It was not exactly coughed up, but hawked up from the back of the throat. She was much troubled by the foul taste, and the fact that her breath was most offensive to others. The expectoration was almost always bloody and separated into two layers, the upper a bright red, but containing very few if any blood corpuscles, the lower white and looking like pus. It consisted, however, almost entirely of squamous epithelium.

"It was quite clear, therefore, that it came, not from the lung, but from the mouth or upper air passages. They were all examined with great care, and pyorrhœa alveolaris found to be present. This was treated, and the expectoration completely stopped.

"The digestion and general health improved remarkably, and not the least benefit was the release from the constant mental worry resulting from the disease."

"The second case was a very similar one. A married lady, aged 25, had good health until March, 1899, when she had a well authenticated attack of right pleurisy which lasted six weeks. Expectoration is said to have begun with the

beginning of her illness, and to have become bloody in October, that is, six months after its first appearance. It was offensive from the first, but more so after it became coloured. There was never any real bright blood. It came up without any actual cough, but she thought that its appearance was preceded by a sort of pain or queer feeling at the lower part of the chest and the epigastrium. She described this as a sort of rasping sensation. The daily amount varied considerably. She had lost a good deal of flesh, and some time before had perspired at night. She was very anxious and troubled about her condition, and disturbed by the offensive taste and smell. She has a long narrow 'phthinoid' chest in which, as is well known, the liver dulness behind often suggests an abnormal dulness in this situation. The physical examination of the chest, however, revealed nothing except a certain amount of retraction and diminution of movement at the right base such as might easily have resulted from the attack of pleurisy. There was, however, quite enough to suggest that the expectoration might come either from a small localised empyema in this situation, or a bronchiectatic cavity, and an exploratory puncture had actually been made. The temperature was normal.

"Examination of the expectoration showed that it consisted exactly of the same materials as that of the last case. She had well-marked pyorrhœa alveolaris.

"After ten days of treatment the expectoration almost stopped, and had become quite free from blood and had lost its offensive smell. She professed herself better in every way, and in a letter written at Christmas time she congratulates herself on the fact that life is again worth living, and says that she has practically lost all her troubles."

"The third case was one of a gentleman aged 66, who had pyorrhœa alveolaris in a marked and advanced condition. It had been under treatment for some time, but had not been continuously carried out, and at the time of the onset of the acute symptoms the suppuration was distinct and the odour of the breath obvious.

"During last summer he had suffered from three or four mild attacks of diarrhœa, recurring with very short intervals, and during one of these he was seized with acute glossitis and stomatitis with most profuse suppuration. The gums became much more swollen and the suppuration copious; the tongue enlarged and became thickly coated, and superficial ulceration occurred at several spots where the teeth impinged upon the lips and the under surface of the tongue. There was for a few days considerable fever.

"The patient had never been told of the state of his gums, and neither the medical attendant nor the surgeon who saw him knew anything about their previous condition. They therefore thought at first that this was a purely acute condition, and were puzzled to account for it. Naturally the first thought was that it might possibly be mercurial salivation. But there seemed no possibility of his having accidentally taken any mercurial preparation. He had for a few days only been ordered a mixture containing bismuth, but it appears quite certain that by no possibility could any calomel have been mixed with the bismuth. And, moreover, the character of the diarrhœa differed in no way from that of the previous attacks.

"I saw him a few days after the onset of the acute symptoms and, as I knew about the previous condition, was able to suggest an explanation of the trouble,

and recommended treatment of the gums. The saliva lost its offensive smell almost at once, the swelling of the tongue subsided, and the salivation diminished; but the ulcers on the tongue were a source of great pain and were slow in healing. The treatment of the gums was continued daily, and they are in a more healthy state than they have been for years. There is now no offensive odour to the breath.

"This case helps to explain the mode of origin of some apparently spontaneous cases of acute stomatitis and glossitis."

(3) **Pernicious anæmia.**—In a series of articles communicated to the *Lancet*,[1] Dr. W. Hunter deals very thoroughly with the disease known as pernicious anæmia. He regards it as a chronic infective disease arising from absorption in some part of the gastro-intestinal tract. The infection, he considers, in nearly all cases has its origin in the mouth, the immediate cause being either the teeth or a stomatitis of septic origin.

There is good reason for believing that many cases of anæmia are directly traceable to septic absorption from the mouth. In one case under care the anæmia appeared synchronously with suppurative periodontitis. Medical treatment in the form of iron and other tonics was tried but proved of little value. The patient then came under treatment for the suppurative periodontitis, the anæmia improving as the discharge from the gums lessened, the patient being eventually cured.

(4) **Puerperal fever.**—The possibility of puerperal fever being due to dental infection is suggested by Dr. Forbes Ross in a communication to the *British Medical Journal*.[2] He states that for some time he has made careful enquiries "for a history of toothache immediately before and directly after confinement or miscarriage in inflammatory cases, and has invariably been able to find conclusive evidence of the existence of some dental disturbance."

(5) **Infective gastritis.**—Dr. Hunter (*Lancet*, January 27, 1900, reports a case of this character.

"This was a case of subacute gastritis in a woman aged 62 years. The patient suffered from severe intermittent sickness and gastric pain, necessitating the use of morphia, lasting eight months, with loss of weight and increasing weakness. Cancer was suspected, but on examination no sign of malignant disease was visible in the stomach, the abdomen, the rectum, or the uterus. Constant complaint was made of a bitter taste in the mouth, nausea, and loathing and dis-

[1] *Lancet*, January 27, February 3, 1900.

[2] March 14, 1896.

taste for all food. The tongue was coated with a dirty moist fur. The patient had false teeth both in the upper and the lower jaws. The plates were scrupulously clean and the gums beneath the plates were perfectly healthy. There were only three teeth in the jaws, and these were decayed, there being suppuration around the roots with pus welling up on pressure. There was no other sign of disease. A provisional diagnosis was made of gastritis caused by continual swallowing of pus. The stumps were ordered to be removed. A week later the tongue was clean, the sense of taste returned for the first time for eight months, and there had been only one attack of gastric pain. In another week there was a return of the sickness, with vomiting and pain and slight fever. The vomit obtained was free from food; it was watery, with rusty flakes consisting of mucus, fibrin, catarrhal cells, leucocytes and blood, the whole being loaded with streptococcus and staphylococcus (pus) organisms and a few bacilli. A diagnosis was made of infective gastric catarrh. As a local antiseptic 3 grs. of salicylic acid were given thrice daily and peptonised milk was also given, and counter-irritation was applied. There was complete cessation of all pain and a steady recovery from that time onward. When the patient was first seen her weight was 9 st. 10 lb., and a month later (after her illness) it was 9 st. 6 lb. Two mouths later it had increased to 10 st. 6 lb. She reported herself well and she has since remained well (after 15 months).

"Up to this time my suspicions regarding the teeth were based on general grounds. Knowing as I did how infective the organisms of dental caries were, such unhealthy teeth seemed to me to be *possible* sources of infection. I had had no proof that infection from decayed suppurating teeth might be the direct cause of gastritis, nor did I know of any observations showing this. This case was a particularly crucial one in this relation. Had the teeth as a whole been very bad, *e.g.*, a number of diseased roots interspersed with fairly good teeth, the condition one so often meets with in hospital practice, and had I had them all removed and replaced with good artificial teeth, I could not have been sure that the resulting improvement was due to removal of the teeth as sources of infection and not rather to improved appetite and better mastication. As it was as regards new teeth no change was made, or, indeed, was necessary. The only change made was the removal of the three suppurating teeth, which had, the patient said, never caused her any trouble, and which indeed she regarded as 'old friends' whose loss she greatly deplored. She said that 'she had had them like that for twelve months or more'—her gastric trouble, be it noted, extending over about the same period of time. I was able to demonstrate further in this case the infective nature of the gastric catarrh, the fluid vomited being loaded with pus organisms three weeks after removal of the suppurating teeth."

(6) **Toxic neuritis.**—Oral sepsis is regarded by Dr. Hunter as a cause of certain forms of neuritis. He records three cases[1] in which immediate improvement of the neuritis followed treatment of the septic condition of the mouth.

(7) **Appendicitis.**—In cases of appendicitis where suppuration

[1] *Practitioner*, December, 1900.

and at times gangrene takes place, there is strong reason to suspect that the infection is occasionally traceable to the mouth.

(8) **General debility.**—The presence of extensive caries in the mouth and suppuration is frequently accompanied by a general debility. The debility is generally attributed to imperfect mastication owing to defective teeth, whereas careful observations of these cases show that the ill-health is mainly due to septic poisoning and infection from the teeth. After the removal of the septic roots and long before the insertion of dentures such patients improve rapidly in health, the improvement being shown in the general tone and appearance and gain in weight. "**No teeth are better than septic teeth.**"

This important subject can hardly be dismissed without drawing attention to the question of the teeth of domestic nurses. As a class they have extremely bad teeth. This, combined with the fact they are frequently fondling the children placed in their care, suggests that infection must at times be transmitted to the children. No actual evidence in support of this theory can at present be adduced, but its reasonableness is sufficiently obvious to justify medical men in pointing out this danger to parents at every available opportunity.

It is to be regretted that the importance of a septic condition of the mouth in surgeons and hospital nurses is not more fully recognised. Contagion may not be conveyed by the breath to any appreciable extent, but it is quite feasible for a wound to be infected by a slight expectoration.

Perusal of the literature on this question of septic teeth and general infection will conclusively prove to the dental surgeon the absolute necessity of removing as far as possible all cases of sepsis and suppuration in the mouth. The days of dentures made over septic roots are past; and roots left in the mouth should be properly treated and filled. It is quite true that in our patients we often find sturdy opponents to our suggested treatment, but if the matter be properly placed before them there will be few who will not listen and agree.

CHAPTER XX.

The Operation of Extraction of the Teeth.

The operation of extraction is one requiring skill, judgment, experience, and an accurate anatomical knowledge of the parts involved. Like all other manipulative proceedings, success can only be obtained by actual practice.

For facility of description the operation will be considered under the following heads :—

(A) The general principles of extraction.
(B) Extraction of individual teeth and roots.
(C) Extraction under anæsthetics.
(D) Extraction of misplaced teeth.
(E) Complications, difficulties, and sequelæ.

(A) THE GENERAL PRINCIPLES OF EXTRACTION.

A careful examination of the tooth to be removed should be made. This will allow some idea to be formed of the amount of sound tissue present, and also of the force which will be necessary for the dislodgment of the tooth. In the case of roots the edges must be defined, and for this purpose a blunt probe will be found useful.

(1) INSTRUMENTS.

The instruments in general use for the removal of teeth are forceps and elevators.

The forceps is an amplified pair of pincers or pliers. It is made up of three parts, namely, the blades or portions beyond the joint which are applied to the tooth, the joint itself, and the handles. Forceps should be made of fine steel, light and yet strong enough to withstand any strain that may be put upon them without bending. The blades should be shaped to fit the tooth they are intended to remove, and should be clear of the crown when applied. On longitudinal section a blade should present a thin wedge-

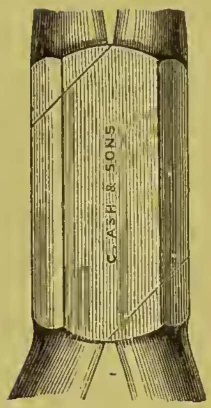

FIG. 579.

FIG. 580.

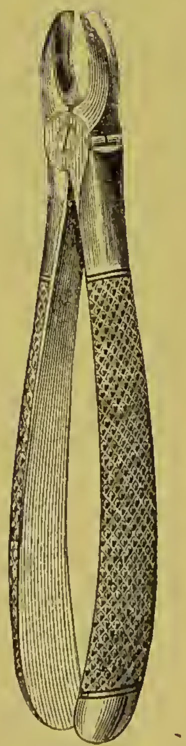

FIG. 581.

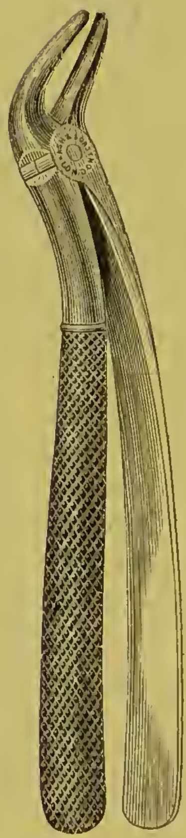

FIG. 582.

shaped appearance. Two kinds of joints are in general use. In the first variety one half of the forceps passes through a slot in the other half, the two being held together by a rivet passing through the centre (fig. 579). In the second variety (fig. 580) the two halves are held together side by side by a screw or pin which takes the entire strain.[1]

Most forceps of English manufacture are made on the latter plan, which has the advantage of permitting the instrument to be

FIG. 583.

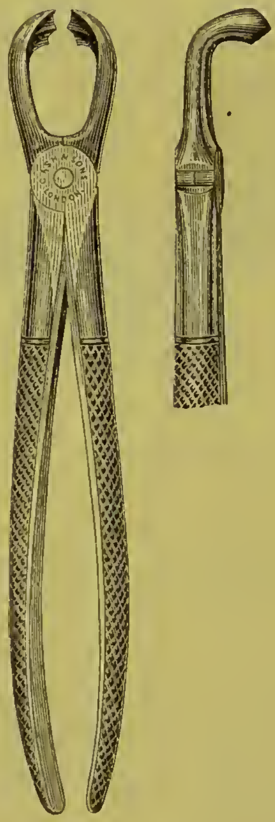

FIG. 584.

easily cleaned; it also allows a slight lateral movement of the two halves—a point of some practical importance. It is urged against this style of joint that it is weak; in practice, however, this is not found to be the case. The handles should be of a size and shape to lie comfortably in the palm of the hand, and should be in such

[1] A description of the different instruments in general use for the removal of the various teeth will be found on pages 559 to 582.

relation to the blades that when the latter are applied in the direction of the long axis of the tooth, the handles clear the lips.

As a general rule, in forceps designed for the removal of the anterior teeth of the maxilla, the blades and handles are in the same line (fig. 581), while for the upper back teeth the handles form a curve of greater or less extent with the blades (fig. 582). In forceps for the mandibular teeth the blades are bent down from the handles to an angle of nearly ninety degrees. In one class named, the "hawk's-bill," when the blades are applied to the tooth the handles are at right angles to the line of the arch (fig. 583), while in other classes the handles are in line with the arch (fig. 584). Forceps with aseptic or readily cleansable joints have been introduced.

(2) METHOD OF HOLDING INSTRUMENTS.

The manner of holding forceps is shown in figs. 585 to 587. The handles should rest comfortably in the palmar surface of the hand, and in such a manner that the end of one handle rests between the thenar and hypothenar eminences—a portion of the hand where force can be applied with the greatest advantage.

The thumb placed between the handles acts as a regulator to control the pressure of the blades upon the tooth. As a precaution it is well to have the ball of the thumb well between the handles, so that the pressure is counteracted not only by the soft tissues, but also by the terminal bony phalanx of the thumb. If this precaution be not observed, any sudden crushing of the tooth may be accompanied by a severe and very painful contusion of the operator's thumb.

The elevator consists of two parts—the handle and the blade. The former, usually made of wood or ivory, is about four inches in length and of a shape suitable to allow a firm grip being obtained. The blade is of fine steel and about two inches long. Elevators are of two varieties, straight and curved. In the first form the blade is thin, about one-fifth of an inch in breadth, one surface being made convex and the other flat. The point of the blade may be rounded as shown in fig. 588A, or pear-shaped, as shown in fig. 588B. In the curved variety, the terminal half inch of the steel part of the instrument is bent at an angle with the shaft of the instrument

(fig. 624). The edge of the blade of an elevator should always be kept sharp.

The screw (fig. 589) is an instrument which on rare occasions is useful for the removal of deep-seated roots.

After being used, instruments of every kind should be freed from all foreign matter and then carefully sterilised.

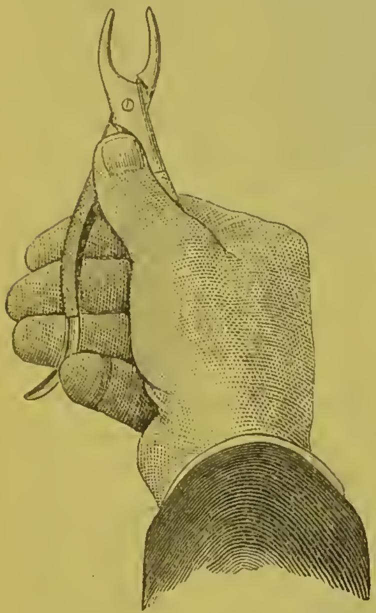

FIG. 585.—Mode of holding forceps for the removal of maxillary teeth.

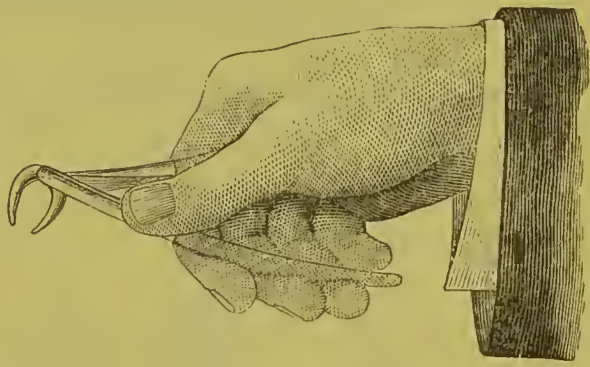

FIG. 586.—Mode of holding lower "hawk's-bill" pattern forceps.

The method of holding an elevator is shown in fig. 590. The handle should rest comfortably in the hand, the first finger lying along the blade and being brought near the point so as to prevent the instrument slipping. When using the elevator for the removal of teeth on the right side of the mandible the finger should lie along the curved side of the blade, and on the flat side when extracting teeth on the left side.

(3) POSITION OF THE OPERATOR AND THE PATIENT.

The chair should be placed before a good light, and if a proper dental chair is not available an ordinary armchair may be utilised; failing this, two ordinary chairs may be placed back to back, on one

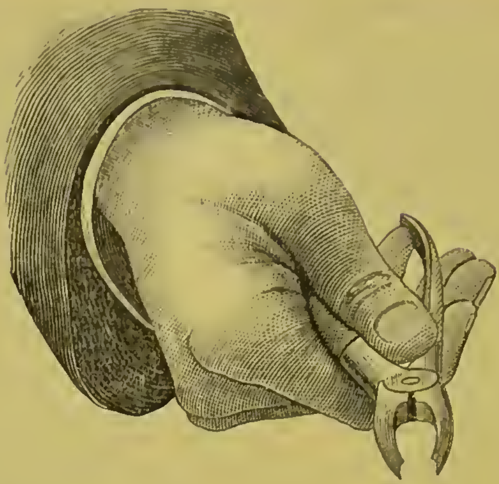

Fig. 587.—Mode of holding forceps of pattern shown in fig. 584.

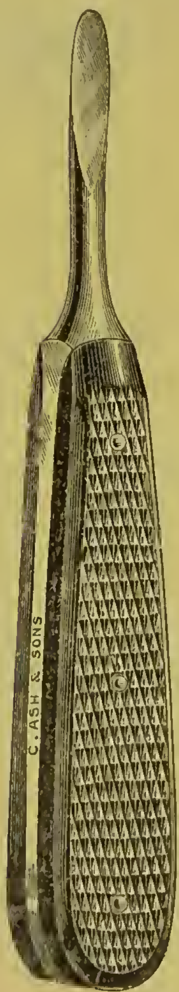

Fig. 588a.

Fig. 588b.

of which the left leg of the operator should be raised to form a rest for the patient's head. The patient should be placed in such an unconstrained position as will allow the operator to exert all necessary movements with freedom.

The operator should place himself so as to use his force to the greatest advantage. His left arm may be utilised, if necessary, for steadying the movements of the patient's head, while the fingers of the left hand can be employed :—

FIG. 589.

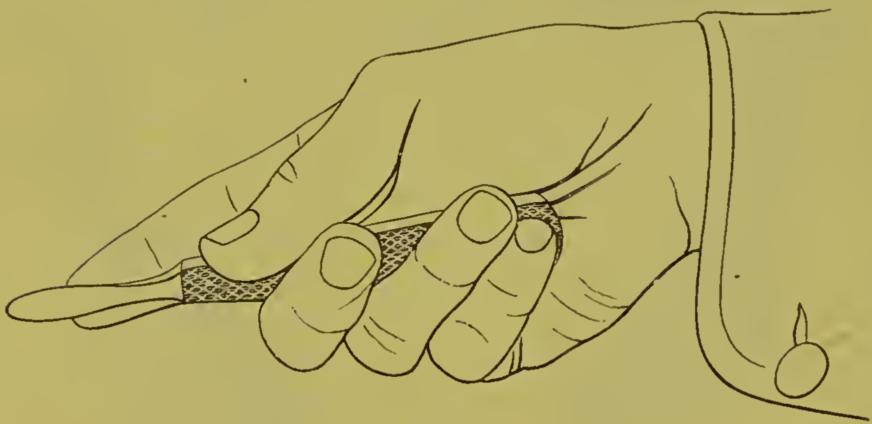

FIG. 590.

(*a*) To keep the cheek and other soft parts away so as to obtain a clear view of the tooth to be extracted and its immediate neighbours.

(*b*) To support the mandible.

(*c*) To grasp the alveolus and so allow some idea to be gained of the effect of the force employed.

The special positions for the removal of different teeth will be described on pages 558 and 567.

(4) ANATOMY OF THE TEETH AND JAWS.

Points in the anatomy of the teeth and jaws which have a direct bearing upon the manner of carrying out the operation of extraction.

If the teeth be examined it will be noticed that they are capable of division into :—

(*a*) Teeth with single, round tapering roots.

(*b*) Teeth with single roots more or less irregularly flattened or curved.

(*c*) Teeth with multiple roots.

Under (*a*) are included the maxillary incisors (deciduous and permanent) and the mandibular premolars ; (*b*) the mandibular incisors and canines (deciduous and permanent), and the maxillary canines and premolars ; (*c*) the maxillary and mandibular molars (deciduous and permanent), and frequently the first maxillary premolars.

The shape of the roots, as we shall subsequently find, has an important bearing upon the manner in which force is to be applied when severing them from their attachments. To ensure skilful and successful operations a thorough knowledge of the alveoli of the teeth is necessary, and it is needless to say that this can only be gained by careful study of the bones themselves (fig. 59). Some idea of the strength of different portions of the alveolar border will thus be obtained, a matter of some moment when applying force in the process of removing a tooth from its socket. The points to be specially noted in the maxilla are the thinness of the outer alveolar wall as compared with the inner, the prominence of the bone in the region of the third molar. In the mandible the outer alveolar border will be seen to be thinner than the inner, with the exception of that portion in the region of the third and often of the second molar ; at the posterior portion of the socket of the third molar the bone is moderately dense.[1]

(5) METHOD OF USING FORCEPS.

When performed with forceps the operation of tooth extraction may be divided into three stages :—

(*a*) Adaptation of the forceps to the tooth.

(*b*) Destruction of its membranous connections with, and dilatation of, the socket.

(*c*) Removal of the tooth from the socket.

[1] A description of the form of each tooth, with respect to its bearing upon the construction of forceps and its removal, will be found under the heading B.

In the initial stage **the first step** is the application of the blades. Care must be taken to see that the points pass between the gum and the tooth, and also that they are applied parallel with the long axis of the root.

FIG. 591.—From "The American System of Dentistry."

As a rule, it is best to apply the blade first on the side of the tooth most obscured from view, and then lightly to close the other upon the opposite side. The blades should then be forcibly pressed upwards or downwards as the case may be, in the direction of the apex of the root; a slight rotary or wriggling motion will

often be found of assistance in the process. This "pressing" movement should be continued until a firm hold of the root has been obtained—a matter of great importance, as the successful removal of the tooth depends in a large measure upon the grip obtained. The handles should next be closed so as to give the blades a firm grip, and the amount of pressure applied should be such that when movement has commenced the blades do not ride upon the surfaces of the root. The amount of pressure must of course depend upon the character of the tooth to be removed, and the resistance offered by the alveolar process. The thumb placed between the handles of the forceps, as already explained, should counteract the pressure on the root and prevent crushing.

The second stage—the destruction of the membranous attachments and dilatation of the socket—is accomplished by employing force in either a rotary or a lateral direction. The movement to be employed depends upon the form of the root or roots to be removed and the resisting strength of the surrounding hard structures, and at this point it need only be remarked that rotary action is admissible only in the case of teeth possessing a single conical root.

The final stage is carried out by exerting extractive force in the direction of the long axis of the tooth as well as in that of least resistance; the latter is determined by a knowledge of the anatomy of the alveolar border and by the sensation conveyed to the hand through the forceps.

(6) METHOD OF USING ELEVATORS.

The removal of a tooth with a straight elevator is accomplished in the following manner.

The blade, with the flattened surface towards the tooth to be removed, is inserted between the root and the alveolus, the instrument being kept as far as possible parallel with the anterior surface of the crown. The blade is then forced downwards so as to reach the root at a point as low as possible; the handle of the elevator is then rotated away from the direction in which the tooth is to be removed. This has the effect of both raising the tooth in its socket and displacing it in the required direction. One such movement of the instrument rarely suffices for the removal of a tooth,

a second, and sometimes a third grip, each time nearer to the apex of the root, having to be obtained.

The method of using **a curved elevator** will be described in dealing with the removal of the roots of mandibular teeth.

(7) CHARACTER OF THE WOUND.

The wound resulting from the removal of the tooth is a lacerated one, and heals by "granulation." The socket, immediately after the operation, becomes filled with coagulated blood, which is eventually replaced by granulation tissue, followed at a later period by the formation of loose cancellous bone. A varying amount of absorption of the alveolar border always follows the removal of a tooth, the continuity in the surface of the gum being restored by ordinary cicatricial fibrous tissue.

The wound is best treated by keeping the parts carefully cleansed as far as possible from all foreign matter, and for this purpose an antiseptic mouth wash[1] should be used several times a day. From the wound resulting from the extraction of a maxillary tooth the discharge drains away in a natural manner owing to the orifice being the most dependent part. From the wound caused by the removal of a mandibular tooth such is not the case, and should suppuration take place the socket must be frequently syringed with some antiseptic solution, and, if necessary, packed with a suitable material.

(8) EXTRACTION DURING PREGNANCY.

In the early months of pregnancy extraction may be safely performed. After the sixth month it is advisable to avoid, if possible, the removal of teeth unless they are causing severe pain which cannot be alleviated by any other means. In such cases the teeth should be removed under deep anæsthesia, as it is important to avoid shock as far as possible. Dr. Routh is of the opinion that

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[1] The following is a useful formula :—

℞ Liquoris potassæ .. .. ʒvi.
Acidi carbolici glacialis .. .. ʒiv.
Aquam ad. .. .. ℥iv.

M. One teaspoonful to be used with half a tumbler-full of warm water as a mouth wash.

the date of gestation does not materially influence the question of extraction unless there is a previous history of abortion at a certain stage.

(9) EXTRACTION DURING THE MENSTRUAL PERIOD.

If extraction is rendered necessary through acute suppuration the tooth may be removed at any time during menstruation, but otherwise it is better to wait until the end of the "period."

(10) EXTRACTION OF THE DECIDUOUS TEETH.

Although the actual details of the extraction of deciduous teeth do not differ from those of the permanent teeth, there are, nevertheless, one or two points to which attention may with advantage be directed. First, when it is necessary to extract a child's tooth, the child must be told. It is an unwise proceeding to deceive children in such matters or take them unawares. The confidence and consent of children can generally be gained by a little practice and moral suasion. It should also be remembered that anæsthetics are quite as needful for the extraction of the deciduous as the permanent teeth, the pain to a child being quite as great as to an adult.

(B) EXTRACTION OF INDIVIDUAL TEETH AND ROOTS.

(1) MAXILLARY TEETH.

For the removal of teeth in the maxilla the patient should be placed at such a level that the arm of the operator can, if necessary, embrace the head of the patient with comfort. The operator should stand at the right side of the patient, and slightly in front, the first finger and thumb being placed on either side of the alveolus (fig. 592). In the event of the patient becoming restless, the arm should be shifted so as to encircle the head and hold it firmly.

(*a*) **Maxillary incisors.**—The roots of both the central and lateral incisors are usually cone shaped, the anterior surface being the arc

of a greater circle than that of the posterior. Forceps for the removal of these teeth ought therefore to have the blades made in a corresponding manner. The lateral incisor is smaller than the central, and has at times a root somewhat flattened. In removing maxillary incisors the posterior blade is applied first, care being taken to see that the edge of the instrument passes between the gum and the tooth. To dislodge these teeth a firm inward movement should be made in a direction towards the palate, this movement being followed by one in an outward direction. If this

FIG. 592.

fails to dislodge the tooth from its attachments, a firm rotary motion, first to the right and then to the left, may be tried (the amount of rotation necessary being only about an eighth of the circle represented by the circumference of the root).

Rotation is generally recommended in the first instance for the extraction of these teeth, but the inward movement is best, the teeth yielding more readily and with less laceration of the soft tissues. The extraction of the roots of these teeth does not as a rule present much difficulty. When moderately sound the instru-

ment shown in fig. 593 may be used, but in those instances where the root is much decayed, and lies well below the gum margin, a rather finer pair will be found more serviceable. The manner of removal is similar to that used when the crown is standing.

(*b*) **Canines.**—These teeth, like the incisors, are single rooted, but the difference between the curve of the anterior and posterior surfaces is greater. The roots too are much longer, more firmly implanted, and hence require more force in their removal.

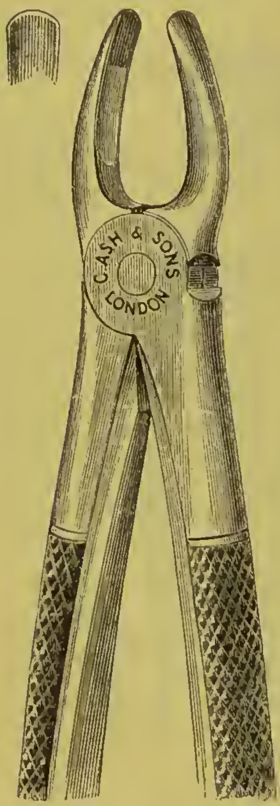

FIG. 593.

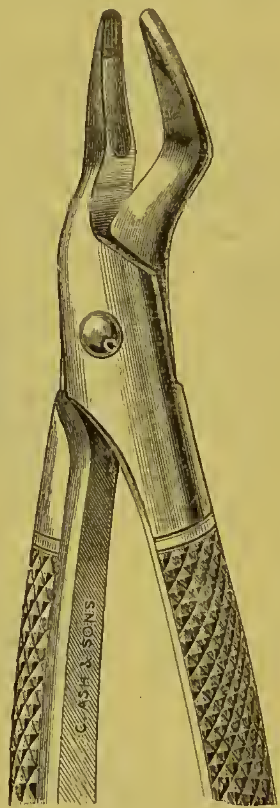

FIG. 594.

Forceps similar in pattern to those enployed for incisors may be used, the severance of the tooth from its attachments being brought about by force applied in an inward, followed by an outward, direction. The root being more or less three-sided, rotation cannot well be adopted. The root of a canine tooth should be removed in the same manner as the whole tooth.

(*c*) **Premolars.**—The first premolar has usually one root flattened and more or less longitudinally grooved on its mesial

and distal surfaces. If this grooving is much marked, it results in a greater or less division of the root into two slender terminations. Whether such bifurcation exists or not can seldom be determined before operation, and would not alter the method adopted, but the tendency to this variation should be borne in mind, and the lateral movement very gently applied. The internal and external surfaces of the root are for all practical purposes of equal curvature.

The second premolar has usually only one root, which is not so flattened in the antero-posterior diameter as the first. There is also less tendency to grooving or bifurcation of the root than there is in the first premolar.

The blades of forceps for the premolars should be equal segments of the same circle; they should also be bent at an angle with the handles, so that the latter may clear the lower lip. The forceps shown in fig. 594 is a useful pattern. In removing an upper premolar, the inner blade of the forceps should be applied first. For severing the tooth from its attachments a slight inward movement should first be made, followed by an outward. If this fails to cause the socket to yield, the inward movement may again be made, and repeated if necessary. The removal of the tooth from its socket is to be carried out by force applied in a downward and outward direction. The removal of premolar roots is carried out in a manner similar to that of the whole tooth.

(*d*) **Molars.**—**The first molar** has three roots, one internal towards the palate (palatine), and two external (buccal); of the three the palatine is the largest; it is subcylindrical in form, and often curved. The two buccal roots are placed in an anterior and posterior position, the latter being in a plane internal to the anterior one; both these roots are somewhat flattened, and of the two the anterior is the larger. The roots of the **second molar** are similar in shape to the first, but are usually smaller.

The third molar, when normal, has three roots, but very frequently these are all fused together so as to form an abrupt tapering cone, the point of which is often curved. Owing to the disposition of the roots different forceps will be required for the removal of upper molars on the right and left side. Of the blades, the outer or buccal should possess two grooves, the anterior being the broader and placed in a more external plane. This blade should also have a slight projection between the grooved surfaces to adapt

itself to the space between the buccal roots. The inner or palatal blade should possess only one groove. A well-made pair of upper molar forceps should fit the neck of a first upper permanent molar perfectly. The blades should be bent at an angle with the handles, so that when in use the latter may clear the lower lip (fig. 595). The palatine blade should be applied first, and in bringing the outer blade into place the point should be kept over the groove on the buccal side of the tooth, as this groove is a guide to the space between the outer roots. To sever these teeth from their attach-

FIG. 595

ments force must be applied, first slightly inwards and then outwards, the movement being repeated if necessary, the removal of the tooth from the socket being carried out by exerting force in a downward and outward direction. Too much outward movement leads to undue bending or fracture of the external alveolar plate.

In removing the third molars it is advisable not to have the patient's mouth opened to the fullest extent, as the tension of the

tissues of the cheek will thereby be lessened and a clearer view of the outer side of the tooth thus gained. The correct application of the forceps is of the utmost importance, as one is liable, unless care is taken, to include some of the soft tissue between the blades and the tooth and so cause a painful laceration. Force applied inwards then outwards is generally sufficient to loosen these teeth, their removal being carried out by a downward and outward movement.

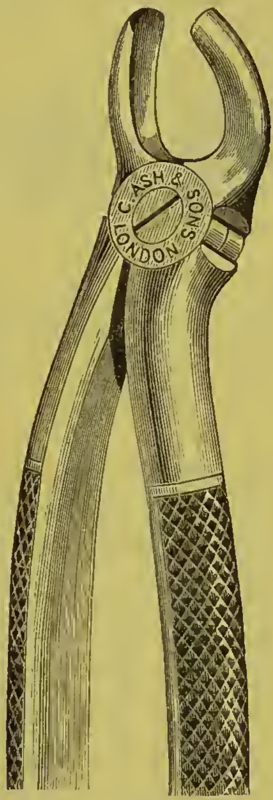

FIG. 596.

Forceps similar to those in fig. 595 may be used for the removal of the third molars, but most operators use patterns the blades of which are similar segments of the same circle (fig. 596). There is an abnormality of the maxillary molars which may with advantage be mentioned here. It consists in the posterior buccal root being situated in a plane much internal to the anterior—in other words, it is an exaggeration of the normal arrangement. Such teeth have been termed by Mr. Booth Pearsall "oblique rooted" (fig. 597). The abnormality is met with most frequently in the third molar,

sometimes in the second, rarely in the first. The difficulty encountered in extracting these teeth is that the outer blade of the forceps tends to slip round. Oblique-rooted teeth can at times be diagnosed by noting an undue prominence of the alveolus over the anterior buccal root, and are best removed with forceps similar to that shown in fig. 596.

In cases where a portion of the crown remains and the decay extends well below the gum on either the palatal or buccal side, ordinary molar forceps should be discarded and root forceps

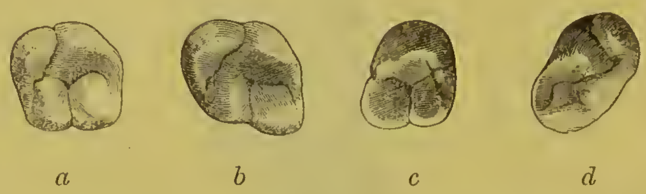

FIG. 597.—(*a*) Normal maxillary first permanent molar; (*b*) Oblique-rooted maxillary first permanent molar; (*c*) Normal maxillary second permanent molar; (*d*) Oblique-rooted second permanent molar.

employed; useful patterns are shown in figs. 598 and 599. The removal of the teeth in this condition is carried out as follows, and for the sake of description it will be supposed that the decay extends deeply on the palatine side. One blade of the forceps should be first applied to the buccal side of the tooth and to the root which is considered the stronger; the inner blade should now be applied to the palatine root, care being taken to insinuate it between the alveolus and the root. The forceps should be pushed well upwards until a firm hold of the root is obtained. A firm inward movement should then be made, as this will allow the inner blade to pass still higher up the palatine root, and ensure steadiness should the blades tend to ride upon the surface of the root. An outward movement should next be made, but to nothing like so great a degree as that used in extracting molars with the whole of the crown standing. This inward and outward movement is to be repeated until the tooth is free, the force being principally applied in the inward direction.

When the more extensive decay has taken place on the buccal side the order of procedure is slightly different. The first blade to be applied should be the palatine, the outer blade being closed

upon whichever of the buccal roots is considered the stronger. The extractive force should be applied first outwards and then inwards, these movements being repeated if necessary, the principal force being outwards, as the object in view is to prevent the instrument slipping off the more decayed side.

When a molar is so decayed that very little of the crown remains, but all the roots are still united, root forceps are indi-

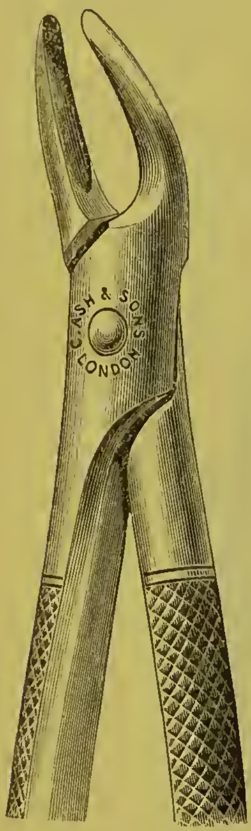

FIG. 598.

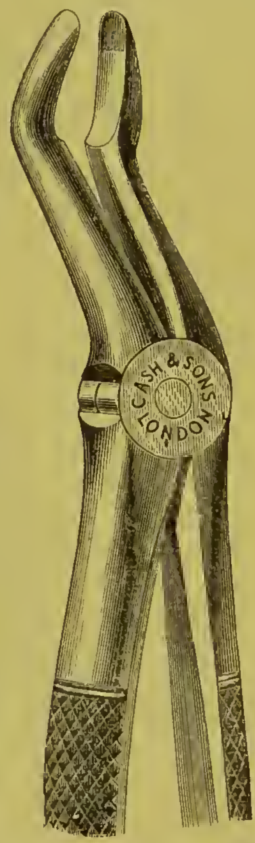

FIG. 599.—For the removal of roots towards the back of the mouth.

cated. In such a case the inner blade is to be applied to the palatine root first, the outer blade being closed upon the stronger of the buccal roots. Inward, followed by outward, movement should be employed, the point to bear in mind being to use force towards the side of the tooth which is considered the weaker. In the majority of such cases the three roots come away together, but even if this does not happen one or perhaps two will be removed, the remainder being subsequently removed with but little difficulty.

In cases where the resistance presented by the roots is very great, and an unsuccessful attempt has been made with ordinary root forceps, an instrument with a buccal blade similar to that shown in fig. 600 may be used. The inner blade is first applied, the outer being inserted, if possible, into the space between the buccal roots. A firm hold of the roots having been gained, an attempt to extract should be made by force applied in an inward and outward

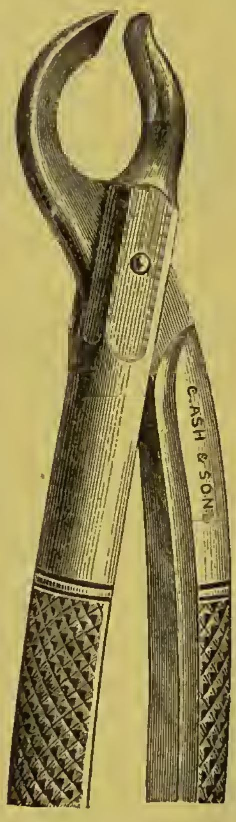

FIG. 600.

direction; this failing, sufficient pressure should be put upon the handles to split the roots asunder. The sharp outer blade of the forceps will then pass between the buccal roots on to the palatine root, which can thus readily be brought away. A pair of ordinary upper root forceps should be employed for removing the buccal roots.

If all three roots of a molar are separate, their extraction presents but little difficulty, a slight rotary movement generally sufficing.

In all cases where there is danger of a molar fracturing, root forceps in preference to ordinary forceps should be used.

(2) MANDIBULAR TEETH.

For the removal of mandibular teeth the patient should be placed on a low level, the head being kept a little forward, and the chin depressed. The position of the operator will depend upon the tooth to be removed and the instrument to be used. With

FIG. 601.

teeth on the right side, when hawk's-bill pattern forceps or elevators are used, the operator should stand behind and to the right of the patient, the left arm being brought round the patient's head. The thumb of the left hand should be placed on the inside and the first finger on the outer side of the alveolus of the tooth to be removed, and the three remaining fingers under and supporting the chin. In placing the fingers in the mouth, care should be taken to keep the wrist well down so as not to impede the entrance of light (fig. 601).

When removing the anterior teeth or those on the left side of the mouth, the operator should stand on the right side and slightly in front of the patient. The left hand should be placed as follows: the second finger on the lingual side, and the first on the labial side of the alveolus of the tooth to be extracted, the thumb being placed under the chin (fig. 602). When employing forceps of the straight

Fig. 602.

pattern shown in fig. 584, the operator should stand as shown in fig. 602, but it will be found difficult to place the fingers of the left hand on either side of the alveolus, indeed, they can only be used with advantage for retracting the cheek and supporting the mandible.

In removing teeth from the mandible, the operator should be careful in raising the tooth from the socket to guard against the

sudden separation of the tooth from its attachments, which might result in damage to the upper teeth.

(a) Incisors.—These teeth have each a single root, which is much flattened laterally. For their removal, forceps similar to those shown in fig. 603 should be used, the blades being equal segments of the same circle. The lingual blade should be applied

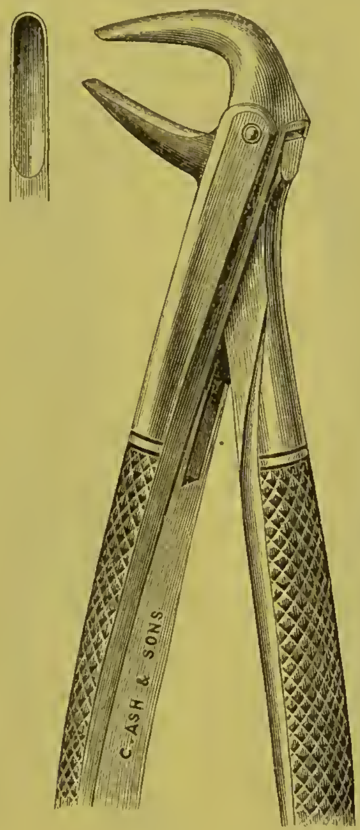

Fig. 603.

first, the loosening movement being made by taking the tooth slightly inwards and then outwards, the final extractive force being upwards and outwards.

The removal of mandibular incisor roots is carried out in a similar manner.

(b) Canines. — The mandibular canines have normally one root, which is flattened laterally. In comparison with the incisors the root is stronger and longer. The removal of a mandibular canine is carried out in a manner similar to that employed for

a mandibular incisor, but as the tooth presents more resistance greater force is usually required.

(c) **Premolars.**—The lower premolars have normally one root, which is conical in shape. In the first premolar the conical shape of the root is not so marked as in the second, the outer aspect being the arc of rather a larger circle than the posterior. Forceps similar to those shown in fig. 603 may be used, the blades being practically equal in size and shape. The lingual blade of the instrument should be applied first, the severing of the tooth from its attachments being carried out by a slight rotatory movement around the long axis of the tooth, first in one direction, then in the other; should this not succeed, a slight inward followed by an outward movement may be tried, the tooth being raised from its socket by force applied in an upward and slightly outward direction.

The roots of mandibular premolars are to be removed in a manner similar to that required for the extraction of the whole tooth. When the root lies much below the level of the gum the extraction is often troublesome owing to the difficulty in gaining a hold with the blades of the forceps; in such cases, if an attempt with forceps has failed, the straight elevator may be employed.

(d) **Molars.**—Mandibular molars have two roots, placed anteriorly and posteriorly. The roots are much flattened, with a tendency to curve backwards, this being well-marked in the second and more so in the third molar; a fusion of the two roots is at times met with in the second and frequently in the third molar. A section of a lower molar at the neck shows both the buccal and lingual surfaces to be composed of two segments of a circle touching each other at one

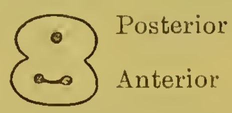

Fig. 604.

extremity, the anterior segment being slightly the larger (fig. 604). Each blade of the forceps used for these teeth should possess two grooves, separated by a projection which fits into the division between the anterior and posterior roots; for all practical purposes the blades may be made of the same size, so that one instrument will suffice for both sides of the jaw. The instrument best adapted

for the removal of these teeth is shown in fig. 605, though some operators prefer the shape illustrated in fig. 606. The advantages of the former over the latter may be briefly summed up as follows:—(1) A clear view of the tooth and its surroundings can be obtained during the whole period of removal; (2) force can be applied with greater advantage; (3) the alveolus can be easily embraced by the fingers, or by the finger and thumb of the left hand.

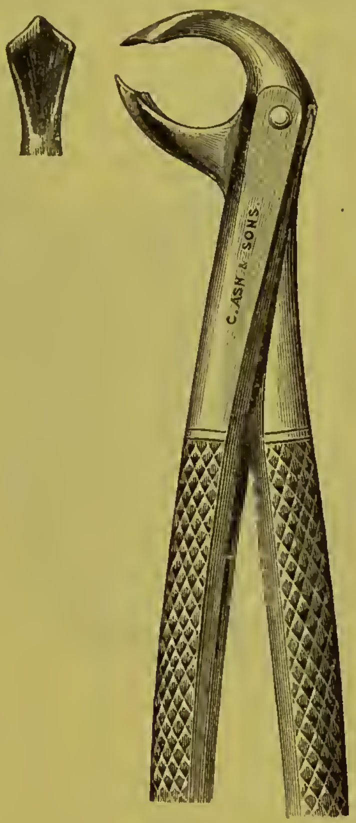

FIG. 605.

FIG. 606.

One disadvantage of shape fig. 605 is the difficulty of employing much inward movement, and therefore, for teeth lying inwards, namely, with the crown directed towards the tongue, hawk's-bill-shaped forceps cannot be easily used. Another disadvantage is that the extent of inward movement is limited by the proximity of the maxillary teeth, and in case of trismus it is often better to use straight forceps.

In removing mandibular molars with forceps, the inner blade

should be first applied and then the outer, care being taken to get the points of the blades between the interspaces of the roots. For severing these teeth from their attachments, a slight inward movement should be first made, followed by one well outwards, this inward and outward movement being repeated if necessary. The removal of the tooth from its socket is carried out by force used in an upward and outward direction. The upward force exerted upon lower teeth should always be well under control, as not infrequently the resistance is very suddenly overcome, and if such precaution is

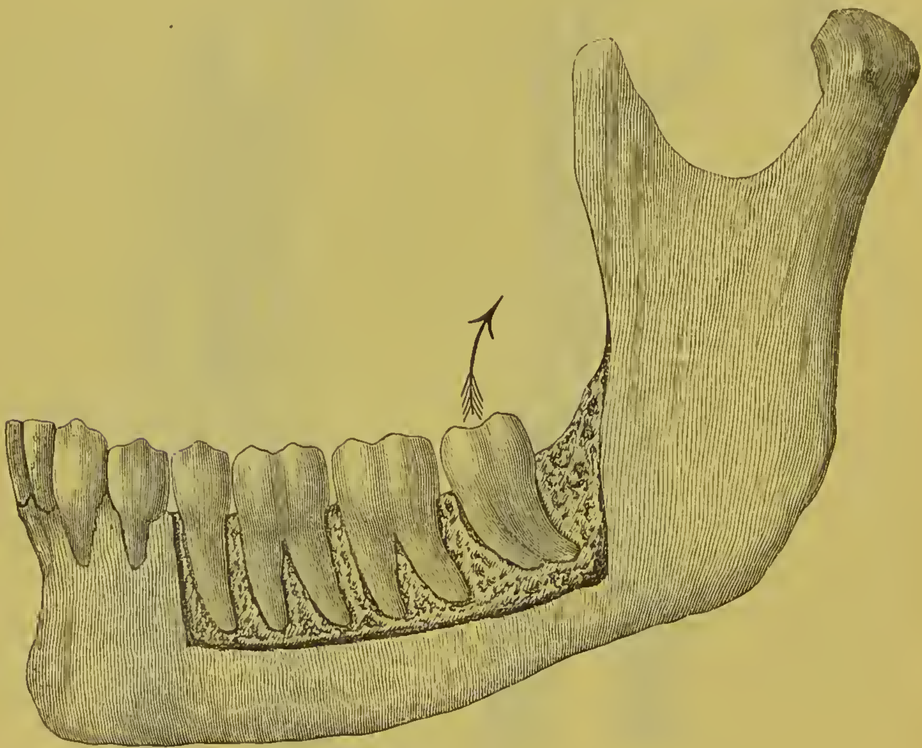

FIG. 607.

not taken there is danger of striking the upper teeth with considerable force. As previously pointed out, the roots of these teeth are at times curved a little backwards, so that it is often needful in removing the teeth from their sockets to twist the forceps in a curved direction backwards.

In the **removal of the second molar**, too much outward movement is to be avoided, as the outer alveolus is often very dense.

The third molar is best removed with a straight elevator.—A glance at the illustration of this tooth (fig. 607) will show that the

roots have a well-marked curve backwards, in addition to which the bone forming the socket of this tooth is stronger than is the case with the anterior molars. The removal of the third molar has therefore to be accomplished by using force in a direction upwards and backwards, in other words, in a curve similar to the arc of the circle formed by the roots. This movement cannot well be carried out with forceps, but is easily accomplished with the elevator as follows (it being assumed that the second molar is in place): Hold the elevator as shown in fig. 590, and insert the blade between the anterior surface of the root and the alveolus, keeping the flattened side of the instrument as far as possible parallel with the root surface. Then force the blade downwards towards the apex of the root, and rotate the handle away from the direction in which the tooth is to be moved. This has the effect of both raising the tooth in its socket and displacing it backwards. The edge of the elevator which is to be brought into contact with the surface of the root should be sharp so as to cut somewhat into the cementum. Should this prove insufficient the handle should again be raised and the flattened end of the instrument brought parallel with the anterior surface of the root, the extractive movement being repeated until the tooth is completely raised from its socket. In using the elevator, especial care must be taken to protect the tongue with the thumb or the fingers of the left hand, so as to prevent a slip which might result in puncture of the tongue.

With the third lower molar there is a tendency for the gum to adhere tenaciously to the posterior aspect of the neck of the tooth. When this happens it is better to simply raise the tooth from its socket with the elevator or forceps, as the case may be, and then cut the gum away with a curved pair of scissors. By this method a severe laceration of the gum may at times be avoided.

When the third molar is isolated owing to the absence of the second molar, the elevator may still be employed for its removal, the first finger of the left hand being used as the fulcrum on the right side and the thumb on the left side. In such cases, however, many operators prefer to use ordinary lower molar forceps.

The removal of mandibular molars when a portion of the crown is standing but the caries has progressed below the gum on either the buccal or lingual aspect, is carried out with root forceps of shape shown in fig. 603. A similar condition in maxillary molars and the method of their removal was referred to on p. 564. The principles

enumerated there apply equally to the removal of lower molars, and it is not therefore necessary to repeat them. The main points to bear in mind are, to apply the blades of the forceps to the stronger root, and to use the principal force in the direction of the weaker wall.

Where the roots of molars are still united root forceps should be used, the blade being first applied to the lingual surface of the

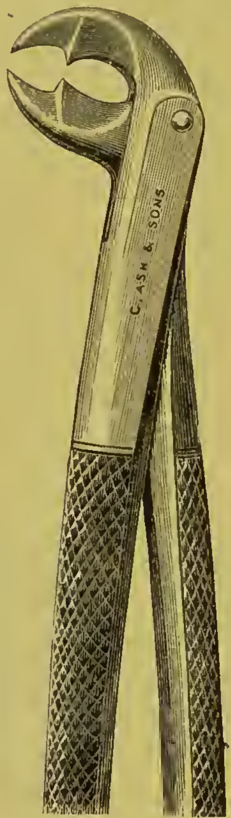

FIG. 608.

stronger root. A firm hold having been obtained, the root may be removed by employing force in a manner similar to that employed with ordinary molar forceps. Both roots will usually come away together. If, however, only one root is extracted, the remaining one can easily be removed, either with the same forceps or with a curved elevator. The curved elevator should be insinuated between the root and the alveolus so as to force the tooth into the empty socket, or the elevator may be placed in the empty socket,

the point being forced through the septum of bone and the root thus elevated.

With roots of mandibular molars which present great resistance, forceps with cutting blades may be used (fig. 608). The blades are inserted on the lingual and buccal aspects of the arch in such a manner that the points pass into the space between the roots. The handles are then closed and an attempt is made to remove the roots in the ordinary way, but should this prove unsuccessful the handles must be forcibly closed, so as to divide the roots, which can then, as a rule, be removed with ordinary root forceps.

The value of splitting roots in a case similar to that shown in fig. 609 is apparent, it allows each root to be removed in the line of its inclination.

FIG. 609.—(*a*) Lower molar with divergent roots; (*b*) the dotted lines show the direction in which the roots can be removed if the tooth is divided as suggested in the text.

In cases where the roots are separated their removal is carried out with root forceps, an inward and outward movement being usually sufficient. The roots of third molars are best removed with a straight elevator. The modus operandi is similar to that used in extracting the whole tooth.

At times the mandibular molar teeth are tilted so that the crown surfaces stand towards the tongue.—Under such conditions their removal is best carried out with instruments of the pattern shown in fig. 606, as the handles of forceps of the hawk's-bill pattern would come in contact with the upper teeth, and thus impede the inward movement which is so necessary for the removal of teeth in this position.

(3) DECIDUOUS TEETH.

For the removal of maxillary incisors and canines, a small pair of straight forceps of the pattern shown in fig. 610 should be used.

The first deciduous molars are best removed with a pair of forceps like fig. 611.

The mandibular incisors and canines require a small pair of hawk's-bill forceps similar to the shape shown in fig. 603. For the

Fig. 610.

Fig. 611.

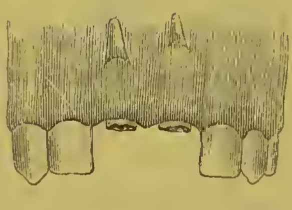

Fig. 612.

deciduous molars, a small pair of forceps similar to that illustrated in fig. 605 should be used.

In removing deciduous teeth, care must be taken not to drive the forceps up too high for fear of injuring the permanent teeth; this is more especially to be noted in connection with the deciduous molars,

as the roots of these teeth practically embrace the crowns of the premolars.

Generally speaking, if a deciduous molar fractures in the attempt to remove it, the portion of tooth remaining in the jaw should be left alone unless it can be brought away quite easily.

Roots in the condition shown in fig. 612 are best removed with an elevator as follows: the thumb of the right hand being placed on an adjacent tooth so as to gain a hold, the point of the elevator should be placed below the end of the root and pressure applied. In a few cases it may be necessary to cut the gum with a lancet before using the elevator. For the small pieces of the deciduous teeth which persist and become wedged in between the permanent teeth, the small curved elevators will be found useful.

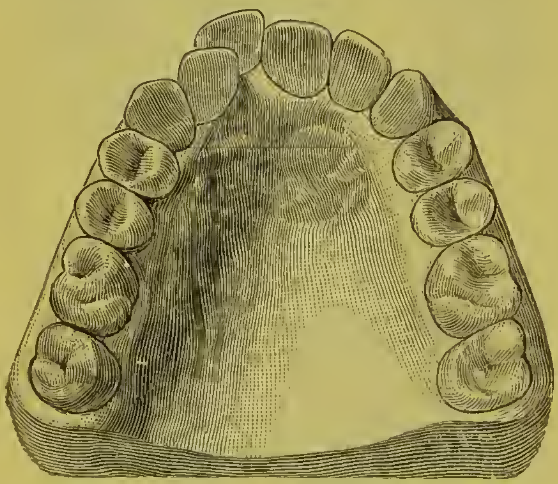

FIG. 613.

(C) THE EXTRACTION OF MISPLACED TEETH.

The extraction of a misplaced or impacted tooth is perhaps the best test of the skill of an operator, and although it is impossible to give a complete list of the various malpositions met with, those most commonly seen will be mentioned, and the usual method of removing such teeth indicated.

(1) MAXILLARY TEETH.

(*a*) **Central incisors.**—An irregularity of this tooth sometimes calling for removal is shown in fig. 613. The extraction is best carried out with an instrument similar to that shown in fig. 614,

the fine inner blade being applied on the palatal side and the broad blade on the labial. Extractive force should be applied principally in the outward direction, and if this is not sufficient, slight rotary movement should be tried. In cases where there is less room between the approximal teeth, the projecting tooth may be removed with a pair of straight forceps (fig. 593), the blades being applied to

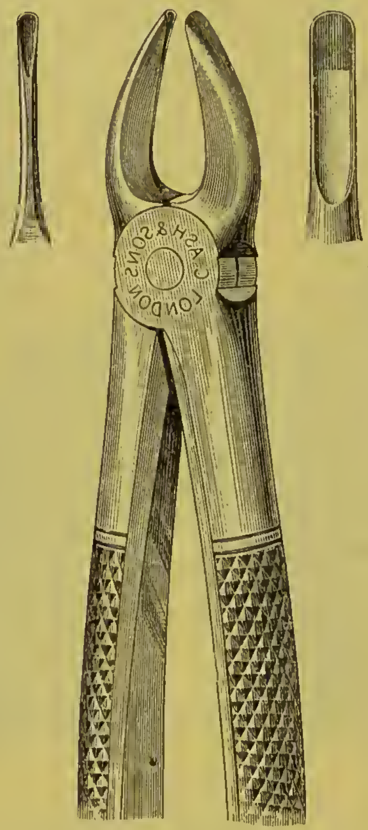

FIG. 614.

the mesial and distal aspects of the root. The blades should not be driven very far up, and the loosening of the tooth should be accomplished by slight rotary motion, but care should be taken to avoid loosening the approximal teeth.

(*b*) Lateral incisors lying internal to the arch, as shown in fig. 615, can be removed with the forceps shown in fig. 614, by placing the fine blade on the labial and the broad blade on the palatal side of the tooth. Extractive movement should be made inwards, followed by very slight outward movement; this failing,

rotation should be tried, but as pointed out on a previous page, this form of movement is not so suitable for lateral incisors as for centrals.

(*c*) **Canines** placed high in the arch, as shown in fig. 616, may be

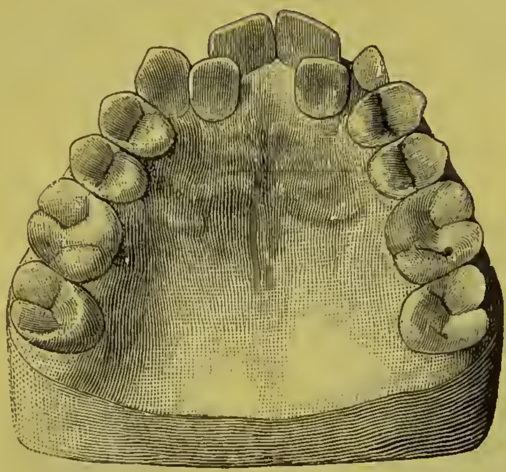

Fig. 615.

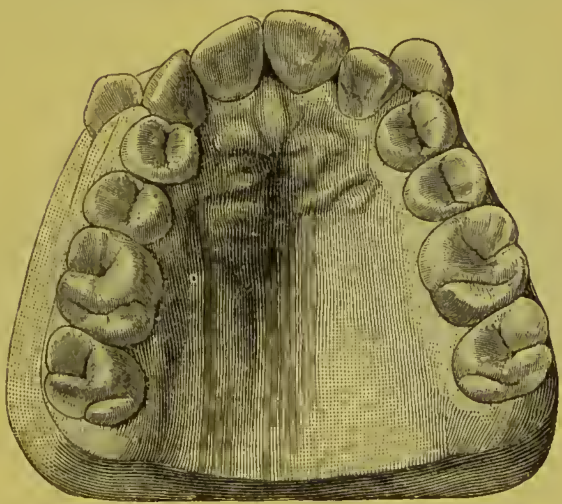

Fig. 616.

extracted with a straight pair of forceps (fig. 593), the blades being placed on the mesial and ~~labial~~ distal aspects of the root. Extraction of such teeth is very difficult. Slight but firm rotation may first be tried; if this fails to loosen the tooth, slight lateral movement may

be attempted, the force being applied towards, and then away from, the median line of the mouth.

(*d*) Premolars misplaced, as shown in fig. 617, can be removed with forceps similar to those in figs. 594 and 598, the blades being applied on the anterior and posterior aspects of the tooth. Force

Fig. 617.

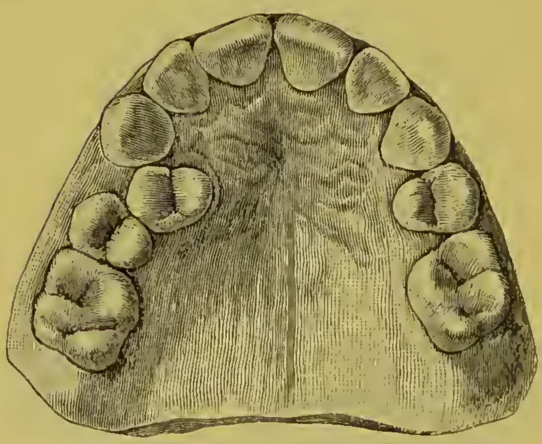

Fig. 618.

should be applied in a backward and forward direction, the movements being repeated alternately until the tooth is loosened in its socket. A premolar placed as shown in fig. 618 can be removed with forceps similar in form to those depicted in figs. 594 and 598, with the outer blade strong but narrow. The extractive movement should be made mainly in an inward direction.

(2) MANDIBULAR TEETH.

(*a*) **Central incisors** placed similarly to that shown in fig. 619 may be removed with ordinary lower root forceps (hawk's-bill pattern), the blades being placed on the mesial and distal surfaces of the root, and movement applied in a direction to and away from the median line of the mouth. When the crowding is not severe (fig. 620) forceps of the hawk's-bill pattern with a strong but narrow

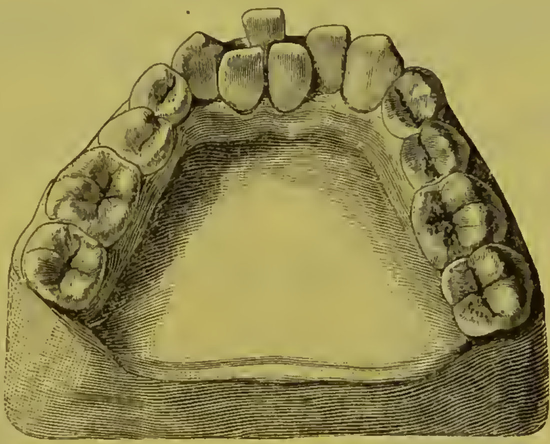

FIG. 619.

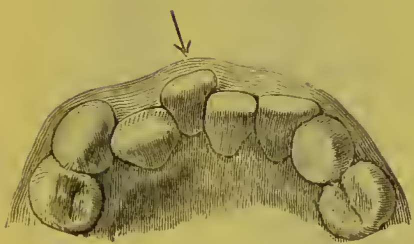

FIG. 620.

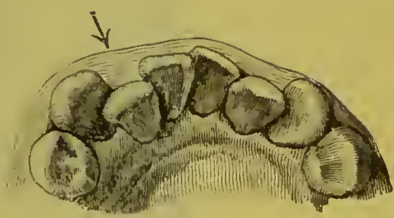

FIG. 621.

inner blade should be used (fig. 622A), and the principal extractive movement made in an outward direction. For an incisor placed as shown in fig. 621 the narrow blade should be the outer one (fig. 622B), and the principal force should be applied in an inward direction.

(*b*) **Premolars** placed as shown in fig. 623 are most difficult teeth to remove. One of the most useful instruments for their extraction is a pair of upper root forceps (Read's pattern, fig. 598),

which should be held so that the curve of the blades is downwards. The blades should grasp the root on its anterior and posterior surfaces. Slight rotary movement may first be attempted, followed by lateral motion. These movements may be persevered with until the tooth is found to yield. Too much haste may lead to a fracture, which would be extremely difficult to deal with.

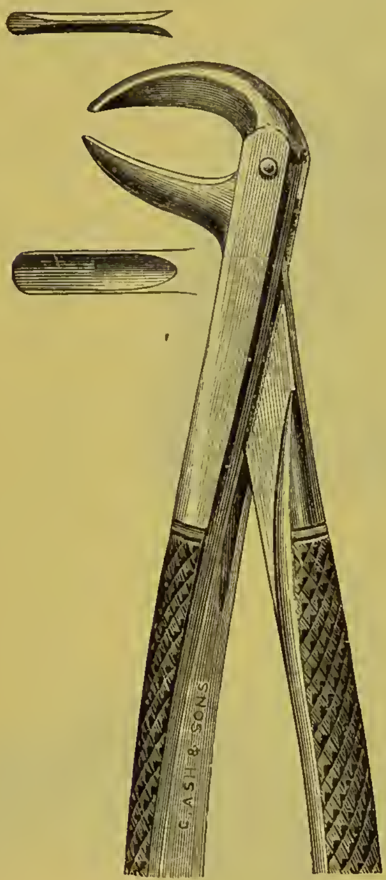

Fig. 622a.

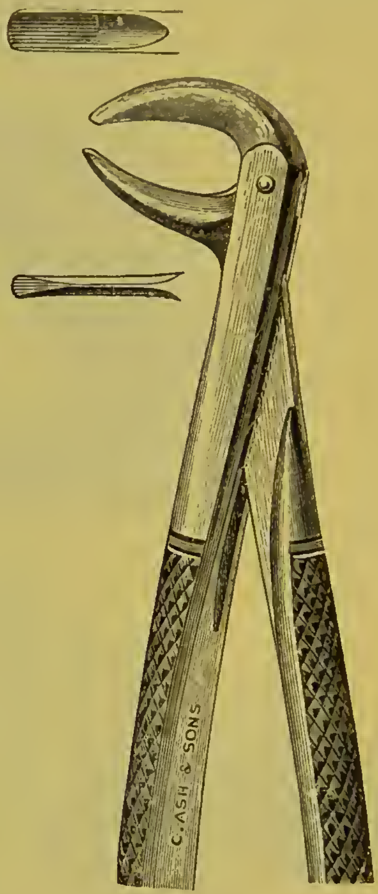

Fig. 622b.

In cases where the crowding is not very marked, and the tooth is more in the normal line of the arch, a forceps with a narrow outer blade will suffice (fig. 622b). Extractive force should be used principally towards the median line of the mouth, and this may be combined with slight rotary movement.

(*c*) **Third molars** when impacted are amongst the most difficult teeth to extract. Where the tooth is deep-seated the gum should be pushed aside by careful packing, and as clear a view of the tooth

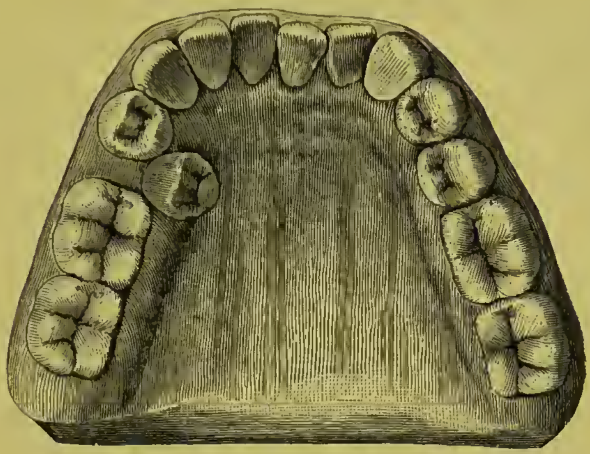

Fig. 623.

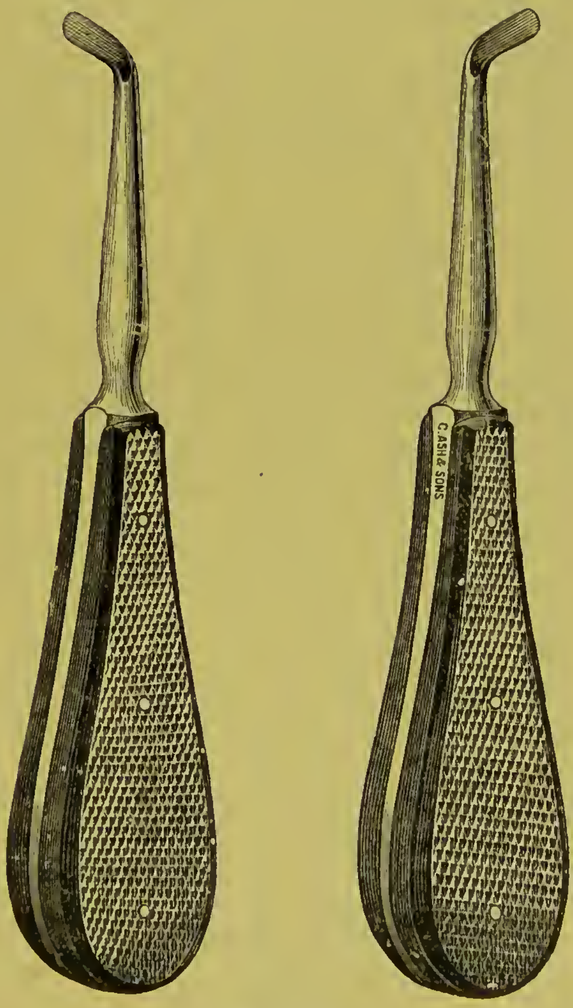

Fig. 624.

as is possible obtained. For removing these teeth it is difficult to give any rules, as each case must be treated on its own merits.

One of the most useful instruments for their removal is a curved elevator (fig. 624), the blade of which can usually be inserted under the crown, and assuming that good leverage is obtainable, the tooth can be prised up. Sometimes the tooth is firmly imbedded in the bone. In such cases a clear view of the tooth may be obtained by gradually packing the soft tissues apart; the periosteum covering the alveolus should then be raised, and the bone surrounding the tooth cut away with suitable instruments. The tooth, when freely exposed, should be removed with an elevator or forceps.

When this tooth is so misplaced as to be buried in the bone, it is advisable to have the patient in hospital. Ether should be given, and the bone, if necessary, removed from around the tooth. The wound thus left will require proper treatment by packing with iodoform gauze, &c.

(*d*) **The extraction of the teeth under anæsthetics.**—The anæsthetics used during the extraction of teeth may be divided into two classes, viz., general and local.

(1) GENERAL ANÆSTHETICS.

It is not proposed to make any allusion to the methods of administering general anæsthetics, as they hardly fall within the scope of this volume. There are, however, a few points which the operator should bear in mind when employing anæsthetics, and which may with advantage be briefly dwelt upon, but before considering them a word or two may not be out of place with regard to the choice of anæsthetics. In dental practice three agents are generally used, nitrous oxide alone or in combination with air or oxygen, ether and chloroform.

Choice of anæsthetics.—In the very large majority of operations **nitrous oxide** should be chosen in preference to ether or chloroform, as it possesses the great advantage over them of being practically safe. In addition, the administration of nitrous oxide occupies a shorter period, and the recovery is rapid and complete. Within the last few years combinations of nitrous oxide with oxygen and with air have been introduced by Dr. Hewitt and Mr. Rowell respectively, and both combinations possess advantages over nitrous oxide used alone.

The advantages of nitrous oxide and oxygen over nitrous oxide alone are:—

(*a*) The anæsthesia is quieter.

(*b*) The mucous membranes of the mouth do not become congested to the same extent, and the operator therefore gains a clearer view of the tooth.

The advantages of nitrous oxide with air over nitrous oxide alone are somewhat similar to those of nitrous oxide and oxygen, though less marked.

For operations requiring a long anæsthesia, such as the extraction of a difficult third molar, ether should be used, the administration being commenced with nitrous oxide. In such cases many operators prefer to use chloroform, but the regular employment of this agent in dental surgery is to be severely condemned, and the cases are rare indeed in which it seems actually necessary. A most careful inquiry into this most important subject has been made by Dr. Hewitt, and the results of his work will be found in an exhaustive paper published in the *Journal of the British Dental Association* for November, 1896, which is well worthy the perusal of all those who are in the habit of administering chloroform.

Whenever a general anæsthetic is given for the removal of teeth two people should always be present, one to confine his attention solely to the administration of the anæsthetic, the other to the removal of the tooth, as it is impossible for one person to operate and at the same time observe the condition of the patient during the anæsthetic period. This rule should be strictly adhered to.

Position of the patient.—For extraction under nitrous oxide and to a great extent under ether, the positions of the patients should differ but little if at all from those already advocated, excepting that the head should not be placed so far back. Before administering any anæsthetic any removable artificial teeth that may be in the mouth should be taken out; the operator should decide exactly what he intends to do; at the same time it is well not to attempt too much and to avoid pricking the gum during the examination of any roots that it may be necessary to extract. The prop should be placed on sound firm teeth in such a position that the operator can work without being hindered by it, and a final view of the mouth should be taken. Where several teeth

have to be extracted at one sitting, their order of removal should be decided upon before the operation is commenced, and if any particular tooth is causing pain it should be extracted first. The order of removal should also as far as possible be arranged so that changes of instruments are reduced to a minimum. As a rule, lower teeth should be extracted before upper teeth, because if the latter are removed first the blood may pass down and so obscure the lower ones. Roots should be removed before whole teeth for the same reason. **Each tooth or root must be cleared from the mouth before any attempt is made to remove another**, except in cases where the gum is thoroughly adherent; under this condition the tooth or root may be left and freed from the gum when the patient has recovered. With teeth which have a liability to slip from between the blades of the forceps, it is well as a precaution to keep the finger of the left hand behind the blades to prevent the tooth passing backwards in the event of its slipping out.

(2) LOCAL ANÆSTHETICS.

(*a*) **Cocaine.**—The most efficacious of the local anæsthetics in use is cocaine. It is an alkaloid obtained from the dry leaves of erythroxylon coca, and in practice the hydrochlorate form is generally used. For the removal of teeth it is necessary to inject solution of the drug into the tissues, a simple application to the gum being of little use.

Cocaine has the reputation of not being thoroughly reliable in its action, but this in a great measure arises from want of care in injecting it. Not more than half a grain should be injected for the removal of a tooth, and even then with people of feeble health untoward symptoms may supervene.

Mode of employment.—For each administration a fresh solution of the drug should be made by dissolving a tabloid weighing half a grain in 5 minims of distilled water. Half of the solution should be injected into the gum on each side of the alveolus. The gum being such a dense tissue the solution should be injected slowly, otherwise the bulk of it will escape by the side of the needle into the mouth. As there is always a tendency for the drug to escape even when the solution is slowly injected, it is well to keep a finger of the left hand pressed on the gum where the needle is inserted.

About eight minutes should be occupied over the injection, and an interval of from four to five minutes allowed to elapse before operating. It is generally found that cocaine is satisfactory as a local anæsthetic so far as its anæsthetic properties are concerned, but the occasional appearance of toxic symptoms, especially in those of feeble health, should not be lost sight of. Tropacocaine has been recommended as possessing the anæsthetic properties of cocaine without giving rise to toxic effects, but this is not fully borne out by experience.

Toxic effects.—The administration of cocaine, especially if given in large doses, may be followed by well marked toxic effects of which the following are cited by Dr. Hewitt.[1] "Headache; vertigo, pallor; a cold, moist skin; a feeble, slow or rapid pulse, becoming imperceptible in grave cases; incoherence of speech, nausea, vomiting, unconsciousness, trismus and other muscular spasms, epileptiform attacks; dilated or unequal pupils, and disturbances of respiration culminating in dyspnœa and asphyxia." The treatment of cocaine poisoning should be directed first to restoring the circulation by the administration of a rapidly acting stimulant, such as sal-volatile, brandy, or the hypodermic injection of ether. The patient should be placed in the horizontal position, and the respiration watched; should the respiration show signs of failing, artificial means must be immediately resorted to.

(*b*) **Freezing agents.**—This group includes such preparations as **chloride of ethyl, coryl** (a mixture of chloride of ethyl and chloride of methyl in such proportions that the mixture boils at 0° C.) and anestyle. Generally speaking, the anæsthesia produced is by no means satisfactory. To use them to the greatest advantage attention must be given to the following points :—

(i.) The gums must be well dried and as far as possible all the neighbouring regions, such as the cheeks and tongue, protected by napkins or other suitable material.

(ii.) The gums must be thoroughly frozen before commencing to operate.

(iii.) The extraction must be carried out as quickly as is consistent with thoroughness.

(iv.) If possible the spray should be continued during the operation.

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[1] "A System of Surgery" (edited by Frederick Treves), vol. i., page 292.

(v.) Too great a jet should not be used.

Freezing agents can be employed much better for front than for back teeth, in fact it is found at times difficult to freeze the gums at all satisfactorily at the back of the mouth.

(E) DIFFICULTIES, COMPLICATIONS AND SEQUELÆ OF EXTRACTION OF THE TEETH.

Like all other surgical operations, the extraction of teeth is at times attended with certain difficulties, complications and sequelæ, which for the sake of convenience will be considered under the following headings :—

(1) Difficulties, complications and sequelæ connected with the teeth themselves.

(2) Difficulties, complications and sequelæ connected with the jaws.

(3) Difficulties, complications and sequelæ connected with the soft parts.

(4) Difficulties, complications and sequelæ arising during extraction under anæsthetics.

(5) Miscellaneous complications, difficulties and sequelæ.

(1) DIFFICULTIES, COMPLICATIONS AND SEQUELÆ CONNECTED WITH THE TEETH THEMSELVES.

(*a*) **Undue resistance of the tooth and alveolus.**—A tooth at times offers considerable resistance to removal. This is naturally most often, though by no means always, met with in persons of strong physique. Isolated teeth are always more firmly fixed than those in series ; this is accounted for by a consolidation of the bone around them. Experience will act as a guide, and it is to a certain extent possible, after a little observation, to gather from the general appearance of the tooth if it will give more than normal trouble in removal. Should undue resistance be met with, steady attempts to move the tooth slightly in different directions should be made and persevered with ; if this precaution is not taken and too much force is used in any one direction, fracture of the tooth or alveolus is sure to result. It may even be found impossible to remove the tooth, and in that case it is best to dismiss the patient and make a fresh

attempt two or three days later; the tooth will then probably be loose, as a result of the inflammation which has been set up by the previous attempt at extraction, and can be easily removed.

The causes of undue resistance are :—

(i.) Abnormal density of the alveolar process.

(ii.) Divergent and twisted roots.

(iii.) Alteration in the shapes of the roots brought about by periodontal inflammation.

(*b*) **Fracture of the tooth.**—The principal causes of this accident are :—

(i.) The use of badly fitting forceps.

(ii.) The use of unnecessary or wrongly applied force in attempting to loosen the tooth in its socket.

A tooth having been fractured, the patient should be made to rinse the mouth until the bleeding has ceased, the socket should be dried with cotton wool, and the position and edge of the root defined with a probe before attempting to remove the fractured portion. It is neglect of these steps that so often leads to failure to remove the remaining portion of a fractured root. Too many attempts to remove a fractured root should not be made; if a second endeavour prove fruitless, the patient should be dismissed and a fresh attempt, if necessary, made after a period of one or two days, as the tooth will probably then be looser from inflammatory trouble; moreover, the hæmorrhage having ceased, it will be possible to obtain a clearer view of the root. Before dismissing the patient, however, an anodyne mouth-wash should be prescribed, and the pulp, if exposed, touched with a strong escharotic. The lower third of a root may generally be left without fear of unpleasant consequences; but it is always advisable to inform the patient when any portion of a tooth is allowed to remain in the jaw, as such knowledge may be of assistance should any trouble arise at a subsequent date.

(*c*) **Crowded and irregular teeth.**—The removal of these has already been referred to on pp. 577 to 584.

(*d*) **The removal of the wrong tooth.**—Should the wrong tooth be removed owing to carelessness on the part of the operator, it must be immediately replaced and if necessary secured with a ligature. If the pulp subsequently shows signs of degeneration or inflammation, it should be removed and the canal treated and filled (see chapter XI.).

(*e*) **Dislocation of a neighbouring tooth.** This accident, which is generally due to a crowded arrangement of the teeth, seems to occur most frequently with the removal of the first permanent mandibular molar, the neighbouring tooth usually involved being the second premolar, which is simultaneously dislocated from its socket. To avoid this contingency the thumb should be placed on the tooth which shows a tendency to move, and only as much force exerted in the removal of the tooth which is being extracted as can be controlled by the thumb. If a neighbouring tooth is removed, it must be replaced and treated in the same manner as described above.

(*f*) **Removal of an unerupted premolar.**—This may be an avoidable or an unavoidable accident. At times the developing premolar is so firmly embraced by the roots of the deciduous molar that during the extraction of the latter tooth the premolar is removed; such an accident cannot be avoided. It is an avoidable accident when it occurs during the extraction of the roots of a deciduous molar through using too much force.

As previously pointed out it is best to leave the fractured roots of deciduous molars alone unless they can be easily removed.

(*g*) **Breaking one tooth in extracting another.**—In the extraction of mandibular teeth with hawk's-bill forceps the maxillary teeth may be fractured. This accident is generally due to inexperience, and arises from the tooth leaving its socket suddenly, owing frequently to the extracting force being used in an upward rather than an outward direction. It may, however, occur when a lower tooth has been more than normally resistant. It is well, therefore, for the operator to be on guard by keeping the thumb or a finger of the left hand over the joint of the forceps. An adjacent tooth may also be fractured in using the elevator.

(2) DIFFICULTIES, COMPLICATIONS AND SEQUELÆ CONNECTED WITH THE JAWS.

(*a*) **Fracture.**—The fracture and removal of a small piece of the alveolus is not an infrequent accident, but fortunately the result is not serious. It is sometimes unavoidable, but at other times is due to placing the blades of the forceps on the outer side of the alveolus instead of between the bone and the root of the tooth.

Extensive fracture is sometimes seen, for instance, in a case that came under notice at the Dental Hospital of London, an unqualified person in removing the first mandibular right permanent molar fractured the bone in a horizontal direction so that the second and first premolars with the canine were completely separated from the body of the bone. Mr. Salter[1] gives an account of an extensive fracture of the jaw which occurred in a lady aged 35. The fracture occurred in connection with the removal of the maxillary central incisors. The right central incisor required some force for its removal, and when it came away the whole of the front of the alveolus was firmly attached to the root. In removing the left central incisor considerable force was required, during the exertion of which the bone was fractured. On examination of the parts the mass of bone corresponding to the intermaxillary bone was found to be merely held in place by the soft tissues. "A vertical fracture extended from the side of the canine up to the root of the nose, then nearly horizontally across to the opposite side, being connected there with another vertical fracture. The lesion passed completely through the jaw from before backwards, and there was a wound in the palate three-quarters of an inch from the alveolar border, through which was considerable hæmorrhage." A still more severe example of fracture during extraction of teeth is recorded by Mr. Cattlin,[2] where, in an attempt to remove a third maxillary molar with an elevator, the tuberosity of the maxilla, a portion of the floor of the antrum and part of the sphenoid were fractured. Fracture of the maxillary tuberosity may occur during the removal of the third molar, and Mr. Nicol[3] records such an accident during the removal of the second permanent molar. In a case recorded by Mr. L. Matheson[4] a transverse fracture of the maxilla occurred in a line between the first and second permanent molars during the removal of the first-named tooth. Direct transverse fracture of the horizontal ramus of the mandible due to extraction of the teeth has also been recorded.

Treatment.—In fracture of small portions of the alveolar process no special treatment is called for except that all loose fragments

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[1] "Dental Pathology and Surgery," page 340.
[2] *Trans. of the Odonto. Soc.*, vol. iii., page 138.
[3] *Ibid.*, vol. xxviii., p. 3.
[4] *Journal of the British Dental Association*, vol. xiv., p. 727.

should be removed. When the fracture is of a more extensive character, the fragments must be retained in position by a suitable form of splint, a description of which will be found in the chapter dealing with fractures of the jaws.

(*b*) **Necrosis** of the alveolus may result from extraction and is generally caused by undue violence or some septic process occurring in the wound. For treatment see chapter XXIII.

(*c*) **Dislocation of the temporo-mandibular articulation.**—The use of too much force in extracting a mandibular tooth may lead to unilateral or bilateral dislocation of the temporo-mandibular articulation if the force is not counteracted. This accident may also be brought about by forcing the mouth open too much with a Mason's gag during the administration of an anæsthetic. It may likewise occur without the employment of undue force in those in whom dislocation has previously occurred. (For treatment see page 630.)

(*d*) **Forcing a root into the antrum.**—This occurs mostly in connection with the extraction of the second maxillary premolar root and buccal roots of the first permanent molar. **If a root** has been dislocated into the antral cavity but **still partly remains in its socket**, the best course to pursue is to leave it alone and not to attempt removal, as the attempt might only result in complete dislocation of the root into the antrum. The socket should be kept quite clean by the continual use of antiseptic washes. As a rule the root gives rise to no subsequent trouble. When a **root has been forced completely into the antrum**, the opening into the latter should be enlarged and the antral cavity thoroughly syringed. For this purpose it is well to use an aural syringe of five or six ounces capacity. The rationale of this form of treatment is that the root may pass out with the return current from the antrum. If this treatment fails, an attempt may be made to remove the root with a little scoop of gutta percha fixed on to a flexible wire. When it cannot be removed in this manner, the cavity should be thoroughly irrigated with an antiseptic solution and the root left alone, as it will in all probability become encysted and not give rise to any subsequent trouble. If, however, the patient has a history of epitheliomatous disease of the jaws further attempts should be made to remove the root. A case where a tooth was forced into the antrum in a patient with a family history of epithelioma of the jaw is recorded in the *Transactions of the Odontological Society*, vol. ii., p. 15, old series.

(*e*) **Forcing a tooth into an abscess cavity.**—This accident

requires similar treatment to the accident just described in connection with the antrum.

(*f*) **Trismus.**—Inability to open the mouth obviously renders extraction of the teeth more difficult than usual. When, however, the closure is the result of inflammatory trouble in connection with the lower molars, an anæsthetic should be given and the mouth opened forcibly with a Mason's gag. If the trismus is the result of tonic contraction of the muscles closing the jaw, ether should be used in order to overcome the resistance of the muscles, as nitrous oxide would not have the desired effect.

(3) DIFFICULTIES, COMPLICATIONS AND SEQUELÆ IN CONNECTION WITH THE SOFT TISSUES.

(*a*) **Extensive laceration of the gum.**—The soft tissues naturally suffer when a tooth has been difficult to remove and may be severely lacerated when the gum is more than usually adherent to a tooth. This complication is most frequently seen in the removal of the mandibular third molar, but it is also sometimes met with in the removal of loose teeth. When the gum is found to be more than usually adherent the tooth should be left in the socket until the gum attachment has been divided with a pair of scissors or a lancet. Continued attempts to remove the tooth with the forceps before the gum has been detached will only lead to increased laceration. In all cases where the gums have been badly lacerated, an anodyne mouth wash should be prescribed.

(*b*) **Wounding the tongue.**—This is most likely to occur under nitrous oxide, as the tongue during anæsthesia is generally swollen, and is, moreover, not under the control of the patient. Wounding the tongue is nearly always due to carelessness in using the elevator. **When the tongue is much lacerated,** the overhanging portions should be trimmed off with scissors and the surface kept clean with antiseptic mouth washes.

If the tongue is punctured and the wound does not involve a large branch of the lingual artery, but yet bleeds freely, the tongue should be drawn forward; if this does not prove successful the insertion of a stitch will generally cause the hæmorrhage to cease.

If the tongue is punctured and a large branch of the lingual artery is involved, the finger should be placed on the back of the tongue and the organ drawn forward; this compresses the lingual artery against the hyoid bone. The bleeding point must then be

sought for, and, if found, an attempt made to twist the wounded vessel. If this fails cauterisation may be tried, and as a last resource, if cauterisation does not stop the bleeding, the lingual artery must be tied.

(*c*) **Bruising the lower lips.**—This may occur in the removal of premolars and molars, and is due to having the mouth insufficiently opened, and using forceps of too straight a pattern.

(*d*) **Injury of the mandibular nerve.**—The mandibular nerve may be injured during the removal of the mandibular molars and premolars. Loss of sensation over the parts supplied by the nerve, with dribbling of saliva, generally follows the accident. Sensation is, however, usually restored, and in cases of laceration the nerve generally unites. Mr. Sewill records a case in which "the roots of a lower wisdom tooth contained a groove and a foramen through which the inferior dental nerve had evidently passed." A similar case has been reported by Mr. R. H. Cumine. Removal of a mandibular third molar was followed by profuse hæmorrhage for ten minutes. and a fearful paroxysm which lasted without intermission for about eight hours. Seven months after the extraction the patient had not recovered.

(*e*) **Hæmorrhage following tooth extraction** is a most important complication, and one which needs prompt treatment. Hæmorrhage is **predisposed to** by a diathesis known as hæmophylia. Of its pathology but little seems to be definitely known. The blood in this condition is said by Walsham to be deficient in fibrin. Hæmorrhage may occur in people not predisposed to the above-named diathesis; in some instances it is probably due to pathological changes in the artery supplying the tooth, these changes being frequently induced by inflammation round the apex of the root, the vessel becoming adherent to its bony surrounding, and is thus prevented from contracting. Another condition, which may or may not have any practical bearing, is the occurrence of hæmorrhage during the menstrual period. I have on two occasions had under notice patients whose teeth have been extracted during this period and in whom hæmorrhage followed, but ceased at the termination of the period. Teeth had been extracted for both these patients on previous occasions without undue hæmorrhage following. An interesting case bearing on the point has been reported by Dr. Dorn.[1]

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[1] *Dental Record*, p. 351, 1897.

"The patient was 20 years of age, of weakly build. Dr. Dorn had previously extracted a tooth, and no undue amount of bleeding followed. On May 5, about seven o'clock in the evening, he extracted a lower molar, no unusual force was needed, the gum was not torn, and when the patient left the bleeding had ceased. About eleven o'clock the following morning the patient returned with profuse hæmorrhage, the mouth being full of clots, and the blood still oozing away. The bleeding, she said, commenced about three hours after going home and had not ceased since, though cold alum and vinegar had been applied. Dr. Dorn plugged the socket with iodoform gauze, covering it with a pad of 'stent.' The following morning he removed the dressing and believing that the hæmorrhage had permanently ceased, he dismissed the patient. About six the same evening the bleeding recommenced and the dressings were reapplied as before. A couple of days after the dressings were again removed and the wound healed in the usual way.

"Her periods were usually regular, she menstruated in April and again in June, but in May menstruation, which should have occurred at the period of the above-mentioned hæmorrhage, was absent. Curiously, a similar occurrence had coincided with severe hæmorrhage from the nose a couple of years previously. Dr. Dorn regards the case as one of vicarious menstruation."[1]

Hæmorrhage is generally divided into three stages—primary, intermediate and secondary. In the mouth we often find the primary running into the intermediate.

The treatment of primary hæmorrhage, or that occurring at the time of the operation, is not of serious import. If it is at all sharp a useful plan is to give the patient some tincture of hamamelis in the water used for rinsing the mouth. At the same time about 15 grains of gallic acid should be administered, and the patient ordered to take a similar quantity every two or three hours until the hæmorrhage ceases. The socket should also be loosely plugged with cotton-wool dipped in some styptic, such as gallic acid.[2]

Intermediate and secondary hæmorrhage is more serious and generally sets in at night. When a case of intermediate hæmorrhage is first seen two important points should be ascertained before treatment :—

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[1] An interesting paper on the subject of extraction during the menstrual period was published in the *Deutsche Monatsschrift fur Zahnheilkunde*, May, 1897.

[2] ℞ Acidi gallici .. .. .. ʒij.
Ft. pulv. viij. One powder every two hours until the hæmorrhage ceases.

(1) Whether the bleeding emanates from the gums or the socket of the tooth.

(2) Whether the blood shows a tendency to coagulate.

The latter point will act as a guide in the choice of drugs for internal administration.

In hæmorrhage from the gum, search should be made for any small vessels that may be the cause of it, and if found they should be twisted or compressed. If the vessel is only partially divided it should be completely severed, as this will probably allow contraction to take place. If the bleeding is capillary in character, a pad of gutta percha, lined with lint, dipped in some styptic and applied with firm pressure, is usually sufficient to stop it.[1] A method which is efficacious is as follows: With a curved needle in a holder, threads of horsehair are passed through the gum from one side to the other (one usually being sufficient). The ends are then tied tightly, the effect being to exert pressure on the gum, and at the same time retain the clot in position.

When the hæmorrhage proceeds from the socket the following mode of procedure is adopted: Some small cone-shaped pieces of non-absorbent cotton-wool are prepared (each about $\frac{1}{3}$ to $\frac{1}{2}$ inch long and $\frac{1}{4}$ inch broad at the base), also a pad of lint and a four-tailed bandage, a syringe, a pair of conveying forceps, some cold water and the chosen styptic are likewise placed ready for use. The socket is first freed from clot, then syringed, then dried out with a pledget of cotton-wool, and directly afterwards one of the cone-shaped pieces of cotton-wool dipped in the styptic (the most useful being tannin) is placed in the socket and forced to the apex with a fair amount of pressure; the hæmorrhage is arrested far more by pressure than by the styptic. More pledgets of wool are inserted until the socket is quite full; a plug of lint is then placed over all and kept in position by antagonism with the opposing teeth, a four-tailed bandage being used for this purpose.

An excellent method of keeping the plug in the socket, if the

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[1] Perchloride of iron should be avoided as a styptic, it nearly always contains some free acid, and is therefore detrimental to the teeth; in addition to this it leads to extensive clotting in the veins, as well as to a certain amount of sloughing of the gums.

approximal teeth are standing, is to wedge a piece of wood between them. Excellent as this plan is, however, if the hæmorrhage is at all sharp it is better to use the four-tailed bandage to make more certain of retaining the plug in position. The number of pledgets of wool inserted in the socket should be counted.

In addition to plugging the socket, hæmostatics should be administered.

The general directions to be given to the patient though apparently trivial are most important and should never be omitted. The patient should be advised to go home very quietly, to avoid all forms of excitement, to assume the sitting position usual during the day, and to use a high pillow at night. The patient should be fed through a bent tube and all fluids should be given cold.

In cases where there is a thin watery blood and no tendency to coagulate it may be fairly assumed that the cause of the hæmorrhage lies in the blood, and such drugs as gallic acid[1] and perchloride of iron[2] are indicated, but when the blood shows a marked tendency to coagulate in the mouth, as often happens, and the bleeding still continues, such drugs as ergot[3] are indicated; in this latter condition it may be assumed that the cause of hæmorrhage lies in want of contractility of the vessel wall, and ergot causes contraction of unstriped muscular tissue. At the time of plugging the socket a dose of gallic acid, perchloride of iron or ergot should be given, and its administration continued at intervals until the bleeding ceases. Mr. Morton Smale prefers a hypodermic injection of ergotine.[4]

The patient should be seen within twenty-four hours after

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[1] ℞ Acidi gallici .. .. ʒij.
Ft. pulv. viij. One powder every two hours until the hæmorrhage ceases.

[2] ℞ Liq. ferri perchloridi .. .. .. ♏xxv.
Aquæ chloroformi .. .. .. ʒij.
Aquam .. .. ad ℥j.
Mitte ℥viij.
M. Two tablespoonfuls every three hours until the hæmorrhage ceases.

[3] ℞ Ext. ergotæ liquidi .. .. .. ♏xx.
Acidi sulphurici diluti .. .. ♏x.
Aquam rosæ .. .. ad. ℥j.
Mitte ℥viij.
M. Two tablespoonfuls every three hours until the hæmorrhage ceases.

[4] Injectio ergotini hypodermica B.P.: 1 of ergotine to 2 of camphor water. Dose 3 to 10 minims, made as required.

treatment, and if the bleeding has ceased the plugs may be removed and an antiseptic mouth wash prescribed. This course is not recommended when the hæmorrhage has been severe; under such circumstances the plugs should be allowed to work themselves out. If the hæmorrhage has not then ceased, the socket should be replugged tighter than before with a plug of wood wrapped in non-absorbent cotton-wool. Should this prove of no avail the actual cautery may be tried; if this fails, and the bleeding is from the mandible, the canal should be trephined and a plug of ivory inserted, so as to compress the artery against the inner plate of the bone. In uncontrollable hæmorrhage from the maxilla, digital pressure on the common carotid opposite the transverse process of the sixth cervical vertebra may be tried; should this fail to stop the hæmorrhage, ligature of that vessel must be resorted to. In one case of hæmorrhage from the region of the third right lower molar Mr. Boyd divided the lip in the median line and reflected the cheek from the jaw. The mandibular canal was then laid open by excising the outer plate of the bone, and the bleeding was arrested by plugging the mesial and distal ends of the canal.

In extreme cases with signs of collapse normal saline solution must be infused into the median basilic vein. Cases of death from hæmorrhage following tooth extraction have been reported.

In patients predisposed to hæmorrhage extraction should be, if possible, avoided; but if the removal of the tooth be absolutely necessary, prophylactic treatment should be pursued for five or six days previous to the operation, by the administration of liq. ferri perchloride, as suggested above, or calcium chloride in doses of 10 to 15 grains three times a day. A new styptic consisting of fibrin ferment, 1 to 10, to which 1 per cent. of calcium chloride has been added, is said by Walsham to act only on the blood, not on the tissues, and to be perfectly aseptic. It was found to be effectual in arresting hæmorrhage after the division of all the veins except the common jugular in a dog's neck. The tooth should be extracted in the early morning, so as to have the whole day for treatment, should hæmorrhage occur. Some hæmostatic should be administered at the time of the operation and the socket plugged at once as a preventive measure, for, be it remembered, it is far easier to prevent the hæmorrhage occurring than to arrest it when once it has commenced. The subsequent treatment will consist in the continued administration of hæmostatic drugs. In regard to the

use of ergot during gestation Dr. Routh is of the opinion that liquid extract of ergot in 10 to 15 minim doses three times a day will do no harm in pregnancy of any date. Larger doses should be avoided as they unquestionably increase the duration of the intermittent uterine contractions and might thus expel the contents if there were a tendency to abortion from uterine action as the primary cause.

(*f*) **Injury of the arteries in the neighbourhood of the teeth.**—Wound of the lingual artery has been referred to under the heading of injuries to the tongue. **Laceration of the ranine, anterior and posterior palatine** arteries may also occur. Such accidents are usually the result of the forceps slipping and are therefore avoidable.

Treatment consists in pressure or in twisting or in tying the divided vessel. In the case of the **anterior or posterior palatine artery** it may be found necessary to plug the foramina which give passage to these vessels.

(*g*) **Pain following tooth extraction.**—The causes giving rise to pain following the extraction of a tooth are :—

(i.) **Incomplete extraction of the tooth,** more especially when the remaining portion contains an exposed pulp.

(ii.) **Too rapid healing of the orifice of the socket.**—It sometimes happens that the margins of the wound left after extraction unite very early, and when this occurs the discharges which naturally come away from the granulating surface at the base of the socket have no exit ; the consequence is that they are retained and set up a local traumatic inflammation, leading to swelling of the surrounding tissue.

(iii.) **Suppuration in the tooth socket.**—This may be due in the first instance to the use of dirty forceps, and under such circumstances it may be classed as a poisoned wound. An examination will reveal the presence of greenish putrid pus, while the tissue around will be much inflamed and the portion immediately bordering the wound will have a tendency to slough. A condition of this kind is often found in hospital nurses and medical students, and is, no doubt, due to infection met with in their daily duties.

Suppuration in the socket may be due to a lowered vitality of the tissue, produced by some such local causes as acute or chronic inflammation, and is specially well seen in cases of extraction for the relief of periodontitis, or where the operation has been performed

in patients suffering from general debility, syphilis, struma, or, in fact, any of those systemic diseases which tend to lower the vitality of the organism.

(iv.) **Extensive laceration of the hard and soft tissues** in the neighbourhood of the socket; and

(v.) **Necroses of the socket of the tooth,** are also fruitful sources of pain following tooth extraction.

(vi.) **The presence in the wound of a foreign body.**—A curious example of this came under notice a few years ago. A patient applied for the extraction of the left first permanent molar. During the operation a portion of one of the cusps disappeared; a search was made for it, but as it was not found, the natural supposition was that it had been removed in rinsing the mouth. The patient for the next three weeks complained of slight pain in the socket for which remedies were tried but proved of little use. Eventually the patient discovered the cusp on the top of the granulation tissue which had filled up the socket. In another case of the same character which came under notice, the offending material was a piece of an amalgam filling. A fractured blade of forceps may likewise act as the offending body.

(vii.) **Injury to the nerve.**—Direct injury to the trunk of the nerve is more likely to occur during extraction of the lower third molar than with any other tooth. It is more than probable that many obscure cases of pain following tooth extraction are due to exposure and irritation of the nerve at the apex of the socket. An interesting case of this character was reported by Mr. Storer Bennett. The patient, a lady, aged 23, had had the third maxillary molar dislocated through the use of a Mason's gag, and as it was considered hopeless to restore the dislocated tooth, it was extracted without difficulty. The socket, in spite of treatment, remained painful for the next twelve days, but in the meanwhile granulated healthily, except at its apex, where by the aid of a mirror and probe a spot about the size of a pin's head was noticed, which caused the greatest agony on being touched. Incision of the nerve produced permanent relief.

Treatment.—The treatment naturally depends very much upon the cause. A thorough examination of the socket should be made with probe and mirror. **When due to incomplete extraction** another attempt, if considered advisable, may be made to remove the tooth. This proving unsuccessful, the socket should be swabbed with an

anodyne drug, and if there is an exposed pulp in the remaining portion of the tooth, the pulp should be touched with strong carbolic acid. The patient should also be advised to use poppy head fomentations.

In too rapid healing of the orifice of the socket the freshly healed surfaces must be separated, the socket syringed out, and a small tent of lint allowed to remain in the orifice for about twelve hours. An antiseptic mouth wash should also be prescribed.

In those cases where the pus is putrid and there is reason to suspect infection, the socket should be thoroughly syringed with some antiseptic, such as hyd. perchlor. 1 in 1,000, carbolic acid 1 in 40; following this the parts should be carefully dried with cotton-wool. A small piece of chloride of zinc should then be introduced and allowed to dissolve in the socket, which must be subsequently kept aseptic by constant irrigation with some antiseptic solution. Suppuration occurs more frequently in the lower teeth than in the upper, the drainage of the latter being more easily effected owing to the dependent position of the sockets. In many cases it will be found necessary to plug the socket tightly with iodoform gauze; this prevents the accumulation of *débris* which would act as an irritant. In cases of suppuration occurring in patients of diminished vitality a tonic form of treatment should be prescribed;[1] the dressing in the socket should be removed two or three times a day and the socket syringed.

Care must be exercised in applying escharotics to sockets to which the nerve may be in close proximity; this is especially necessary in dealing with impacted lower third molars. Two cases illustrating this point have come under my notice. In the first a mandibular second premolar with a long-standing chronic abscess had been removed. The patient complained of pain, the socket was syringed out and a small piece of chloride of zinc inserted. Intense agonising pain followed, which all local anodynes failed to relieve. In the second case an impacted right lower third molar had been removed. The socket suppurated, and the pain, although severe, was not intense. Treatment similar to that used in the first

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[1] ℞ Ferri et quiniæ citratis .. .. gr. vi.
Aquæ chloroformi .. .. ʒij.
Infusum quassiæ ad. .. .. ℥i.
Mitte ℥viij.
M. Two tablespoonfuls three times a day after meals.

case was adopted, with similar results. Since then in all cases where it is possible that the trunk of the nerve may be in close proximity to the socket, I have used non-irritating antiseptic injections and plugged the socket with cotton-wool dipped in tincture of opium with much more satisfactory results. It is advisable to inform the patient of the possibility of pain following the extraction of a tooth, especially after periodontitis, and in all cases after extraction a mouth-wash[1] should be prescribed; for even if there is no pain, it will prevent the discharge from the sockets of the teeth undergoing putrefactive changes.

In pain due to necrosis of the socket, deodorant antiseptic injections must be used, while in extensive laceration of the soft and hard parts, an anodyne mouth-wash[2] may be tried. In all **obscure cases** some local anodyne, such as tincture of opium or cocaine, should be applied to the socket, and a mouth wash having similar properties should at the same time be prescribed.

(4) DIFFICULTIES, COMPLICATIONS AND SEQUELÆ ARISING DURING EXTRACTION UNDER ANÆSTHETICS.

(*a*) **Tongue slipping back.**—During extraction under anæsthetics the tongue not being under control may slip over the larynx, or may be forcibly pushed back by the fingers of the operator. Symptoms of difficult breathing or even arrest of respiration will follow this accident. It is not sufficient to merely watch the chest walls, as respiratory movement may continue without air entering the lungs. **Treatment** consists in pulling the tongue forcibly forward with a suitable instrument and forcibly extending the head on the spinal

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[1] The following will be found useful:—

℞	Boro-glyceride (Barff)	aa. ʒiv.
	Eau de Cologne	
	Tinct. krameriæ	
	Spirit vini. rect.	ad. ℥iv.
	M. Fiat lotio.	

To be used with water as a mouth wash. Shake before using.

[2] ℞	Zinci sulphatis	gr. viij.
	Zinci chloridi	gr. vi.
	Morphinæ acetatis	gr. ij.
	Aquam ad.	℥viij.
	M. Fiat lotio.	

To be used with an equal quantity of water as a mouth wash.

column. Pushing the mandible forward with the thumbs behind the angles will usually suffice.

(*b*) **Forcing out a tooth with a prop or a mouth opener.**— With a prop this accident may arise from resting it upon the teeth which are loose or from placing it in such a position that undue leverage is brought to bear on the teeth. It is an accident most likely to occur when the prop is fixed on the front teeth and the mouth opened to its widest extent. Under such conditions undue leverage at right angles to the long axis of the tooth is brought to bear upon the palatal surfaces of the upper teeth and they are consequently forced outwards.

With a mouth opener the accident is due to clumsiness; great care should therefore be exercised when using this very powerful instrument. If a tooth is forced out it should if possible be immediately replaced.

(*c*) **Passage of a foreign body through the isthmus of the fauces.**—A foreign body, such as a tooth, a broken piece of forceps or a prop, passing through the isthmus of the fauces may become impacted in either the air or food passages.

(i.) In the air passages it may lodge (α) over the entrance of the larynx, (β) in the larynx, (γ) in the trachea or bronchus.

(ii.) In the food passages it may lodge (α) in the pharynx, (β) in the œsophagus, (γ) at the pyloric opening of the stomach.

(i.) **In the air passages.**—Should the foreign body lodge **over the entrance of or in the larynx**, the patient will be seized with a violent fit of coughing which may expel it; but should this not happen, symptoms of asphyxia will supervene. With regard to treatment: the head should immediately be brought forward and the finger inserted along the side of the mouth into the pharynx, and then given a forward sweeping movement; by this means the foreign body, if lodged at the back of the tongue, will probably be removed.

This failing the patient must if possible be inverted and a forcible slap given on the back. If the foreign body is not dislodged by this method, laryngotomy should immediately be performed. There must be no hesitation about the performance of this operation and it must be carried out promptly, for the longer it is delayed the less becomes the chance of saving the life of the patient.

A foreign body in the trachea or bronchus usually gives rise to a violent fit of coughing, with signs of impending asphyxia. These signs pass away, to be followed at intervals by fresh attacks of

coughing and eventually by symptoms of collapse of the lung or lungs. In a case recorded by Sir William MacCormac,[1] during the removal of a maxillary premolar the palatine blade of the forceps snapped off close to the joint and disappeared. The patient immediately suffered from great dyspnœa and appeared to be dying. The symptoms passed away, and for the following six weeks the patient's condition gave no great cause for anxiety, although she suffered from a constant hacking cough accompanied by bloody expectoration. Seven weeks after the accident she was admitted into St. Thomas's Hospital, the foreign body was with difficulty removed from the right bronchus, and the patient made an excellent recovery.

The diagnosis of a foreign body in one bronchus is made by an absence of signs of respiration over the whole or part of the lung on that side, with exaggerated sounds (puerile breathing) over the opposite side. Treatment consists in performing tracheotomy and removing the foreign body.

(ii.) **In the food passages.—A foreign body impacted in the pharynx** will give rise to pain, symptoms of dysphagia and dyspnœa. A hacking cough is generally present. Should a foreign body be suspected in the pharynx, its presence can usually be ascertained by digital exploration; this failing, the cavity should be examined by the aid of a laryngoscope.

An attempt should first be made to remove the body with the fingers, and if this is unsuccessful pharyngeal forceps must be called into use. In some cases, where the impaction is very firm, it may be necessary to perform pharyngotomy.

A foreign body in the œsophagus will cause dysphagia, and will probably give rise to constant pain; if it is situated in the upper part it will in all probability give rise to dyspnœa. On applying the stethoscope over the region of the œsophagus, a gurgling sound will be heard when the patient swallows fluids. The presence of a foreign body may be definitely ascertained by passing a bougie; this step will also enable the surgeon to determine the position in which the foreign body is lodged. The X-rays may also be employed.

If impacted in the upper part of the œsophagus an attempt may be made to remove the impacted body with forceps; this failing, œsophagotomy must be performed.

If lodged near the cardiac end of the œsophagus an attempt may

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[1] *The Journal of the British Dental Association*, vol. vii., p. 32.

be made with a bougie to push the foreign body into the stomach; this failing, gastrotomy should be performed.

If a foreign body becomes impacted at the pyloric opening of the stomach, it will give rise to gastric dilatation. Under such circumstances the stomach must be emptied of its contents, and gastrotomy then performed.

(5) MISCELLANEOUS DIFFICULTIES, COMPLICATIONS AND SEQUELÆ.

(*a*) **Uterine pain.**—A case is quoted by Mr. Sercombe where extraction of a tooth was followed by paroxysmal uterine pain, followed by the cure of an obstinate leucorrhœa.[1]

(*b*) **Shock.**—The fact that **tooth extraction is a surgical operation,** and may be followed by shock, is often overlooked. The amount of shock which follows as a rule is practically *nil*, but at times, especially in the weak, it may be well marked. The effects of shock are not taken sufficiently into account when a question arises as to the number of teeth to be extracted at one sitting. It should clearly be borne in mind that a strong, able-bodied person can bear more severe operations than one of weaker physique. **The extraction of a large number of teeth at one sitting** is seldom advisable, and the amount of prostration that follows is sometimes very severe.

Syncope at the time of the operation sometimes occurs. In these circumstances the operator should immediately desist until recovery ensues. Fainting is best treated by bending the head down towards the knees, at the same time loosening anything tight about the neck and applying ordinary salts of ammonia to the nose. **In severe cases** the patient should be removed from the chair and laid on the floor, and the chest should be exposed and flipped with a towel dipped in cold water. **In more severe cases** it may be necessary to inject ether or some other stimulant, such as brandy. **Fatal syncope** following tooth extraction has occurred, and a case which took place at Marseilles in 1881 is mentioned by Tomes.[2] The patient was a female, and an attempt was made to remove a tooth, but owing to alarming syncope the operation was

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[1] *British Journal of Dental Science*, vol. iii., p. 221.

[2] *The Journal of the British Dental Association*, vol. vii., p. 32.

abandoned. A second attempt was about to be made, when fatal syncope ensued. *Post-mortem* examination showed nothing beyond a slight amount of cerebral congestion.

(*c*) **Epilepsy.**—In those predisposed to epilepsy an attack often commences immediately after the extraction of a tooth. In the event of a fit occurring, the patient should be removed from the chair and placed on the floor, the clothes being at the same time loosened, and a wedge of wood or some suitable material placed between the teeth to prevent injury to the tongue.

(*d*) **Hysteria.**—Manifestations of this disorder at times follow tooth extraction, but do not call for any special treatment beyond that usually adopted for this disorder.

(*e*) **Septic and infective sequelæ.**—Scattered through dental literature will be found a large number of records of septic and infective diseases which have followed the extraction of teeth. In many of these cases it would be difficult to say that the infection was traceable to the operation; in a number of them the actual cause was due to the neglected condition of the tooth which called for extraction. Infection can, however, at times undoubtedly be traced to the operation, and once again attention is drawn to the urgent necessity of adopting antiseptic precautions. Suppuration of the socket and its appropriate treatment has already been dwelt upon (p. 599). Cases of syphilis acquired through the use of infected forceps are recorded, while septicæmia, sapræmia, cellulitis, osteitis, osteomyelitis, periostitis, pyæmia, tetanus, have all been known to follow the removal of a tooth. The treatment of these conditions hardly lies within the scope of this work.

CHAPTER XXI.

Replantation, Transplantation and Implantation of the Teeth.

Replantation is an operation which consists in replacing in its socket a tooth which has been partially or completely dislocated.

Transplantation is the operation of transferring a tooth from its own socket to that of another tooth. The transference may take place in the same mouth, or the tooth may be extracted from the mouth of one person and transferred to that of another.

Implantation is an operation consisting in the formation of an artificial socket in the bone for the introduction of a natural tooth.

Of these three operations, the only one which is performed to any extent in this country is replantation, the other two being of questionable utility.

(A) REPLANTATION.

The conditions under which this operation may be performed are (1) traumatic dislocation, and (2) obstinate cases of chronic periodontitis.

The operation, in the first instance, consists in gently rinsing the tooth in a solution of some antiseptic (hydrarg. perchlor. 1 in 2000), and replacing it in the socket with firm pressure, the alveolus being moulded around it with the fingers. The tooth may be kept in place by a tin splint similar to that recommended on p. 96. If the patient is not seen for some hours after the accident the pulp must be removed, and the canal filled before the tooth is replaced.

When the operation is for chronic periodontitis a different procedure is recommended. The tooth, after being extracted, must be held in a piece of lint dipped in some antiseptic, the canals being thoroughly cleaned, rendered aseptic, and filled. Any roughness

about the apex of the tooth should be removed, and any diseased periosteum scraped away. The socket must then be rinsed with an antiseptic, and the tooth, having been rendered aseptic, should be replaced with firm pressure and kept in position with a splint. The after-treatment consists in keeping the parts quite clean by frequently washing the mouth with antiseptic and astringent mouth washes.

The union after replantation is brought about through the periodontal membrane. In cases where the tooth is living and is immediately replaced, the vitality of the pulp is sometimes re-established. Magitot, who has recorded a large number of cases of replantation, maintains that the operation cannot be successful unless there is a complete ring of healthy membrane on the tooth.

The results of replantation depend upon the nature of the condition for which the operation is undertaken. If for traumatism and the tooth is immediately replaced a successful result may be hoped for; but if replacement is delayed the prognosis is naturally not so good. In cases of chronic periodontitis a permanent result can seldom be expected, few replanted teeth being retained for a longer period than five or six years. Teeth which have been removed after replantation show signs of rarefying periodontitis.

(B) TRANSPLANTATION.

There are three distinct objections to the operation: (1) the liability to failure; (2) the risk of inoculation; (3) the moral objection. Failure of the operation may be due to (*a*) want of adaptability of the tooth to its new socket; (*b*) morbid conditions of the new socket; (*c*) applying ligatures to keep the transplanted tooth steady. The risk of inoculation is a strong argument against this operation—a case of transmitted syphilis has been recorded within recent times. The moral objection to the operation is also weighty, as the teeth to be transplanted are usually obtained from the poorer classes. All circumstances considered transplantation of a tooth from one patient to another is to be condemned. The transplantation of a tooth from one socket to another in the same mouth is occasionally useful, as, for example, in the transfer of a healthy lateral incisor which has erupted internal to the arch to the socket of an unsaveable central incisor. The method recommended for carrying out transplantation is as follows: The patient to receive

the transplanted tooth is first operated upon, as little injury as possible being inflicted, and the bleeding from the socket arrested as far as possible. The tooth to be transplanted is next removed from the other patient and immediately transferred to the vacant socket and forced well into place if needful with a hammer.

Union in transplantation may be similar to that which takes place in replantation, or the process may be entirely different and similar to that occurring in implantation, viz., absorption of the transplanted tooth first taking place in various situations. In these excavations bony tissue is formed continuous with the alveolus, the tooth thus becoming anchylosed to the jaw. In other cases it seems possible that there is only a fibrous union.

(C) IMPLANTATION.

This is an operation of more recent date than the two first described, but is one that is probably less justifiable even than transplantation. Dr. Younger, who was the first to perform this operation, is very particular in the choice of his patients, selecting only young and healthy subjects. The tooth to be implanted should possess a healthy periosteum.

The method of procedure is as follows: A crucial incision is made over the situation intended for the implanted tooth; the flaps of periosteum are then dissected up, and by means of specially designed trephines and burs a fresh socket is made. The socket is then syringed so as to remove all *débris*, and after this the bleeding is arrested with cold water, the tooth being fixed into place and, if necessary, secured with ligatures or other suitable means. Some operators force the tooth into place with a hammer, in this way the tooth is firmly fixed and ligatures are not required. Dr. Younger, to perform implantation, does not necessarily use freshly extracted teeth, but employs in some cases dry teeth.

The union taking place after implantation is probably similar to that following many cases of transplantation. Dr. Amoëdo advocates slight decalcification of the roots previous to implanting. The root is placed in a 10 per cent. solution of hydrochloric acid for three to four hours until the surface of the cementum is slightly softened, the acid being afterwards neutralised with ammonia. The results obtained from implantation are not encouraging, and do not justify the operation.

CHAPTER XXII.

Fractures and Dislocations of the Jaws.

(A) FRACTURES OF THE JAWS.

In dealing with this subject it will be convenient to consider it under two heads :—

(1) Fracture of the mandible.

(2) Fracture of the maxilla.

(1) FRACTURE OF THE MANDIBLE.

Fractures occur more frequently in the mandible than in the maxilla, and this is probably due to the mandible being in a position more exposed to injury.

(*a*) **Causes.**—Fractures are mostly the results of kicks, a blow of the fist, a fall (especially on the chin) or gun-shot injuries. Undue violence in the extraction of teeth may fracture the jaw, but a direct transverse fracture is rarely caused in this way. Fracture of the alveolus during extraction is of common occurrence, but as it leads to nothing more serious than the exfoliation of the portion fractured, it is of little importance. Some rare causes of fracture as, for example, a fit of coughing, are recorded in "Gross's Surgery," p. 964.

(*b*) **Varieties.**—Fractures of the ascending ramus are usually simple, those of the horizontal ramus always compound. The bone is usually fractured in one place, but double or triple fractures are not uncommon. In the cases of gunshot wounds and similar severe injuries, the fracture is comminuted.

(*c*) **Position.**—The position of the fracture will depend, firstly, on the situation in which the blow is received ; and secondly, on the presence of any weak spot in the bone such as might be caused by loss of teeth at certain points. Fractures are far more

common in the horizontal than in the ascending ramus, Hamilton recording 52 cases of fracture of the horizontal ramus out of a total of 55. The most common situation of fracture is the neighbourhood of the canine tooth on the side nearest to the premolar, the explanation generally accepted being that the depth of the canine socket weakens the bone at this spot. The region of the mental foramen, symphysis in the young, and the last molar, are other common situations. Fractures of the ascending ramus are generally the result of great violence and may occur in almost any situation, the angle and condyloid process being frequent seats of the injury, and, more rarely, the apex of the coronoid process.

(*d*) **Direction.**—The direction of the line of fracture in the horizontal ramus is usually oblique, though when occurring at the symphysis it may be quite vertical. It is sometimes horizontal, involving the alveolus of several teeth, and a severe case of this character is mentioned by Tomes, in which a fracture, running level with the apices of the teeth, and carrying the premolars, canines and incisors, had occurred in an attempt by a chemist to extract a right mandibular first molar.[1]

(*e*) **Symptoms.**—The symptoms are generally well marked when the fracture occurs in the horizontal ramus; but in the ascending ramus the symptoms are often obscure. In both the patient usually complains of pain on opening the mouth. In the former there will be distinct crepitus, mobility in the continuity of the part and frequently alteration in the line of the teeth, due to displacement. There is often more or less salivation and in some cases, when the displacement is great, an inability to close the mouth.

(*f*) **Displacement.**—The displacement will vary according to the character and situation of the fracture, being slight in some cases and well marked in others.

In the region of the canine the displacement is produced by the action of the muscles and the obliquity of the fracture. The direction of the fracture is usually from within, outwards and forwards, so that on the lesser fragment there is a greater extent of the outer than the inner plate of the bone. This is diagrammatically shown in fig. 625. The displacement in such a case is brought about as follows :—

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[1] "Dental Surgery," Third edition, p. 623.

The left external pterygoid will tend to force the smaller fragment towards the right, and the right external pterygoid tend to draw the greater fragment to the left side. If the line of fracture be directly transverse, as shown by the dotted lines, the force of the two external pterygoids would be equalised; but as the line of fracture is usually oblique, the tendency of the external pterygoids will be to cause the lesser fragment to slide over the greater. The lesser fragment will also be drawn up by the muscles which close the jaw, because they are unopposed by any depressors of the jaw; the latter muscles are all attached to the greater fragment and depress that fragment. The right and left depressors combined exerting more force than the counteracting right elevators.

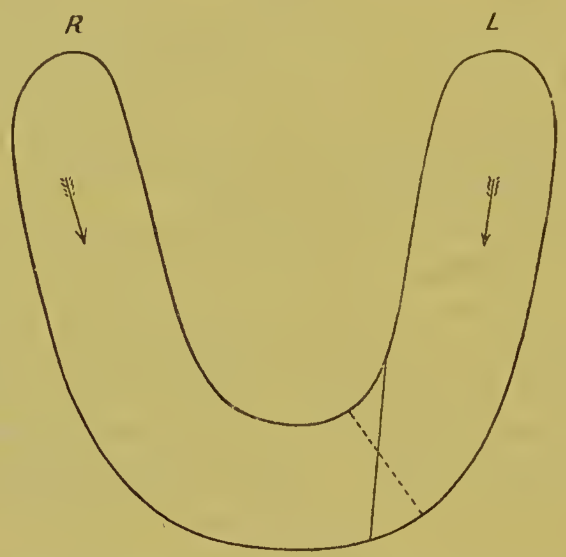

FIG. 625.—The arrows indicate the direction of force exerted by the external pterygoids.

In double fractures through the canine regions, with the lines of fracture taking oblique directions, the following displacement may occur: the central fragment has attached to it the digastrics, the genio-hyoids and the genio-hyo-glossi, the action of these will be to depress the fragment, and at the same time cause it to fall over towards the tongue. The elevators of the mandible are attached to the lateral fragments, and draw them slightly up. The left external pterygoid will tend to draw the left fragment to the right side and the right external pterygoid the right fragment to the left

side, with the result that the lateral fragments are drawn towards the median line and tend to increase the inward displacement of the central fragment. In reducing fractures of this kind it is important to keep these facts in mind.

With **fractures in the region of the last molar,** the direction of the fracture is often transverse. The lesser fragment will be drawn upwards by the elevators of the mandible of that side and towards the median line by the external pterygoid. The greater fragment is drawn down by the depressors of the mandible and towards the injured side by the external pterygoid.

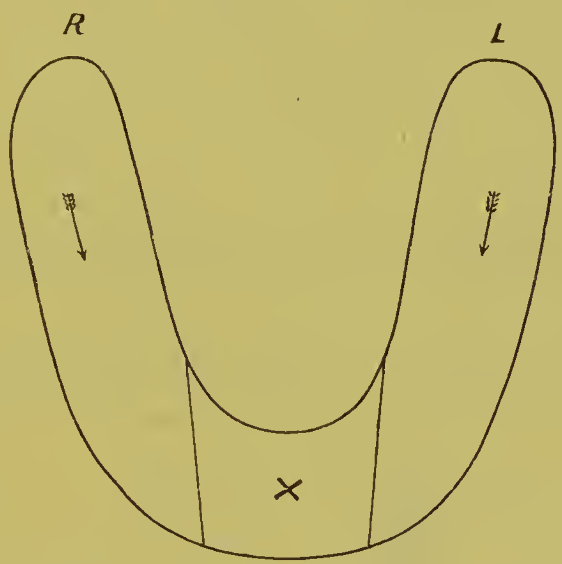

FIG. 626.—(X) Central fragment to which the depressors of the mandible are attached. The arrows indicate the direction of force exerted by the external pterygoids.

Fractures of the ascending ramus are generally accompanied by much swelling, but present little displacement. Pain is, as a rule, referred to the fractured part, and by passing the finger of one hand well back in the fauces and applying the other outside, crepitus may generally be obtained. In severe cases the upper fragment may be tilted forward by the action of the temporal muscle.

In **fracture about the angle of the jaw** the pain is often referred to the third molar or mental foramen, and when the soft parts are much swollen the fracture may easily be overlooked altogether.

Fractures of the condyle are generally accompanied by some pain and a difficulty in moving the affected side, while crepitus may be apparent to the patient. The condyle may be drawn forward on the eminentia articularis by the external pterygoid muscle, and this displacement can be felt by the finger inside the mouth. In these cases the chin is turned a little towards the injured side, not from it, as in the case of unilateral dislocation of the articulation, an important point in the differential diagnosis.

(*g*) **Complications.**—Complications occasionally arise, such as severe wounds of the face, especially the lips, hæmorrhage from laceration of the soft parts, or even rupture of an artery. In one case which came under notice, a traumatic aneurism formed, which necessitated ligature of the common carotid. Dislocation and fracture of the teeth may occur, and also paralysis and neuralgia, arising from injury to the mandibular nerve, or implication of it in the callus.

Dislocation, injury to the base of the skull, and necrosis of the ends of the fragments, leading to abscess and salivary fistula, may be complications.

(*h*) **Ununited fractures.**—Fractured jaws generally require a splint to retain the fragments in position for about six weeks, and as a rule respond readily to treatment. Occasionally union is delayed, or does not take place, the causes being practically the same as those which lead to ununited fractures in other parts of the body. In the mandible necrosis is the principal cause of non-union, the disease producing a considerable space between the fractured ends. Other causes are unusual difficulty in treatment, the slipping of a tooth or some foreign body between the fragments, and want of rest due to a badly-arranged splint.

Suppuration in the region of the fractured ends is at times due to the presence of septic roots or pulps. These roots should be removed or the pulps treated before the splint is applied.

In ununited fractures one of two things generally happens, either a "**false joint**" is formed, or "**fibrous union**" takes place between the fractured ends.

(*j*) **Treatment.**—(i.) **External splints.**—**For treatment** various methods are adopted, the simplest being **a four-tailed bandage,** and to this a splint of gutta-percha forms a valuable adjunct. The splint should be lined with chamois leather, and several holes should be made to allow of evaporation. The parts should also be

sprinkled with some dusting powder, to prevent decomposition. To make the splint, a piece of gutta percha is cut similar in shape to that shown in fig. 627. This is softened in hot water and the part (*a*) is placed under the chin, the two ends ($a_{\prime}$) being bent upwards over the ascending ramus; the portion (*b*) is then bent round as shown in fig. 628.

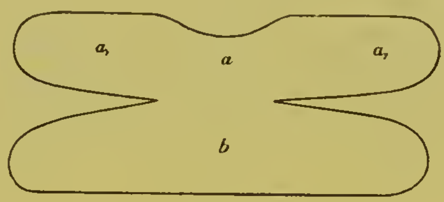

FIG. 627.

The gutta percha splint and bandage are useful as temporary measures during the manufacture of an interdental splint.

The objections to the bandage and its adjuncts are these :—

(α) To apply them it is necessary to bind the mandible tightly against the maxilla, and accordingly prevent mastication, &c.

(β) Any tendency to displacement is not overcome.

FIG. 628.—From Heath.

(γ) In oblique fractures they cause the fragments to overlap by the pressure applied from without and so increase the displacement.

(ii.) **Interdental splints.**—Of **interdental splints** there are three which deserve attention, viz., the Hammond or wire splint, the Hayward or Kingsley class, and the Gunning, each being useful in its proper place. To make an interdental splint the first step is to obtain impressions of the maxillary and mandibular teeth. This is

not always a simple operation, and at times it is necessary to take the impression of the mandibular teeth in half trays. Wax is the best material to use for these impressions, as it requires little heat to soften it and is easily removed from the mouth. If wax is not to hand composition may be substituted; it is advisable not to allow the material used to become hard before removing it from the mouth. When the models have been cast, the lower one should be divided at he line of fracture, and the fragments pieced together so that the bite can be carefully adjusted to the upper teeth. By this means the original contour of the lower teeth is obtained. The fragments are then united in their new positions and the splint made to the corrected model.

FIG. 629.—Hammond splint. The fracture is supposed to be between the central and lateral incisors upon the right side of the figure.

(*a*) **The Hammond or interdental wire splint** (fig. 629) is an excellent contrivance in suitable cases. It is made by bending soft iron wire and adapting it as accurately as possible to the model, the wire running on the lingual and labial sides of the teeth, the ends being joined by soft solder. Some prefer to fit the wires to the mouth, but unless great haste is necessary, this seems a needless and painful proceeding.

When the splint has been prepared the fragments are brought into position, and the splint placed over them, the teeth being fixed to the splint by means of ordinary iron binding wire. The method of passing the wire is as follows: The end of the piece to be passed should be cut obliquely and given a slight upward curve, and inserted

from without over the top of the outer bar, a downward direction being maintained in order that it may be passed under the inner bar; with the forefinger of the left hand the point must be felt for and the wire returned over the inner bar and brought out under the outer one, and the two ends twisted together and bent down under the bar (fig. 629). The reason for passing the wire over the bar at the outset is, that if it be passed under the outside bar, in returning, the wire will have to be passed under the inner bar, which is by no means as easy as returning it over the bar. By giving the wire a slight upward curve as suggested, it is not only easier to pass, but the risk of pricking the side of the tongue is lessened. To prevent traumatic inoculation by pricking the finger with the wire, Mr. Newland Pedley has devised two pairs of forceps with suitable curvatures and also a spoon-shaped spatula. The latter protects the mucous membrane of the mouth, reflects light and assists in directing the tip of the wire upwards. The teeth should be free from calculus before the splint is applied. When other teeth are available those adjacent to the fracture should not be wired. It is well to ligature on both sides the two teeth next to the one adjacent to the fracture and after that each alternate tooth (see fig. 629). After applying the splint the patient should be seen within a week, as the wires generally require tightening. An antiseptic mouth-wash should be prescribed and its frequent use insisted upon.

A modification of this splint has been suggested by Mr. Pedley and is extremely useful where the lesion is anterior and the displacement is not great. To quote Mr. Pedley's words:[1] "the main strand is not passed behind the last tooth, but between two teeth on each side of jaw in the following manner: The point of the wire is sharpened by being divided obliquely with cutting pliers, and passed into the cavity of the mouth between the premolars or the more posterior teeth, and is brought out again by being pressed from the lingual surface between two teeth on the opposite side of the jaw. The intervening portion now lying on the tongue is manipulated into close contact with the lingual surfaces of the necks of the teeth. The wire is then carried across the labial surfaces of the teeth, and its ends twisted loosely together. It is not desirable to twist up the main strand very tightly at first, for so doing would impede the passage of the binding wires, and tend to drag away the

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[1] *Trans. Odonto. Soc.*, vol. xvii., p. 16.

strand from the lingual surface of the teeth. The binding wires are passed in the usual way, and twisted together loosely at first. Finally, all the wires are twisted tight, a few turns being given to first one and then another; the ends are cut short and tucked under the splint to avoid excoriation of the mucous membrane. Rarely should a binding wire be attached to a tooth immediately contiguous to the line of fracture." A useful way of fastening the ends of the main strand is to pass the main wire through a piece of closely-fitting metal tube and give the ends a turn in the opposite direction.

A small but useful **modification of the Hammond splint** has been suggested and used by Mr. H. Lloyd Williams for the treatment of fractures far back in the mandible, when only one tooth is

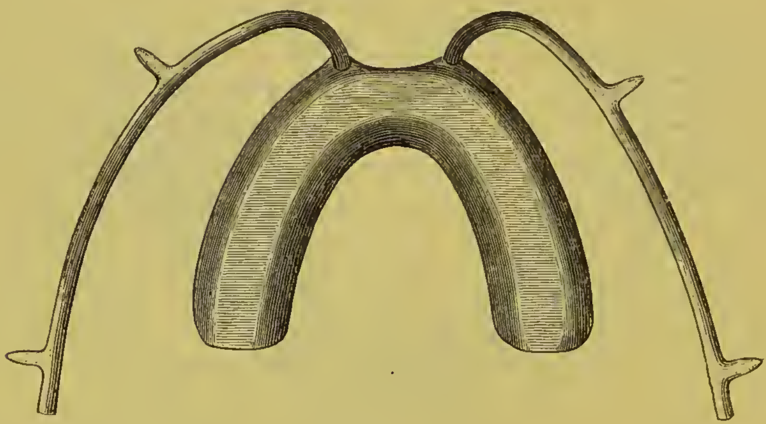

FIG. 630.

standing in the smaller fragment. The splint is made in the usual way except that it fits loosely round the tooth in the smaller fragment. A vulcanite cap exactly fitting the single tooth is then fixed to the splint, the top of the cap being filed off so as to allow the cusps of the tooth to articulate correctly with its antagonist. The splint is bound in the usual way to the larger fragment, the weight of which is sufficient to keep the lesser fragment in position. In seven cases treated in this way Mr. Lloyd Williams obtained successful results in six.

(β) **The Hayward splint** (fig. 630), sometimes known as a Kingsley, consists of a vulcanite cap fitting the teeth; into the sides iron wires are fixed in such a way that, when in position, the wires lie outside the mouth. The wire should be about one eighth of an inch in thickness, should curve well up as it emerges from the

mouth to avoid rubbing the lips, and should terminate at the posterior border of the ascending ramus.

It is well to solder on two points, one towards the front and another towards the back of the wire, the front one preventing the bandage slipping forward (a constant trouble), while the back is useful for fixing the bandage when pressure about the angle is required. These splints are generally made to fit a little loosely, and are then filled with a thin layer of gutta-percha. A perfect fit is thus ensured. The splint should be made to articulate accurately with the upper teeth. When ready for insertion the gutta-percha should be thoroughly softened, the displacement reduced as much as possible and the splint forced into position.

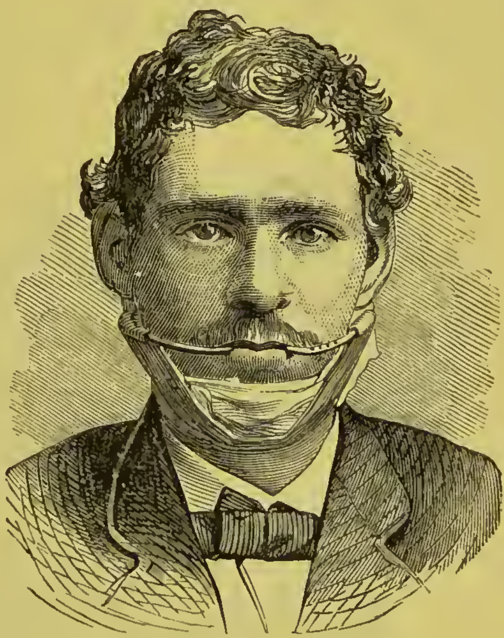

FIG. 631.

A compress of some kind is then placed under the chin and the whole fixed with a figure-of-eight bandage (fig. 631). In applying the bandage care must be taken to avoid its slipping too much forward. With children, if the operation is likely to prove at all painful, it is as well to administer an anæsthetic. The mandible in this class of splint is fixed between the vulcanite cap inside and the bandage outside the mouth.

The wire wings are considered an objection to this splint because

they prevent the patient lying on the side and thus cause discomfort. The modification shown in figs. 632 to 635[1] overcomes this objection. The splint is constructed from an ordinary fret saw frame (fig. 632). The handles and the parts marked *a* and *b* are removed.

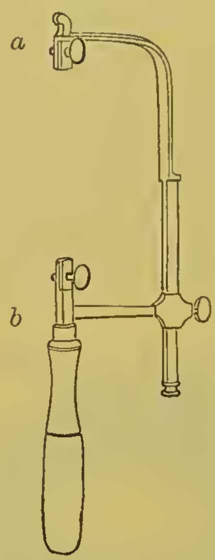

Fig. 632.

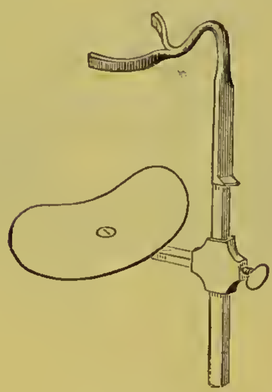

Fig. 633.

To the lower part of the frame a revolving brass chin-piece is attached, and the top part of the frame bent and split as shown in fig. 633, and to this the vulcanite cap is attached (fig. 634). The appliance in position is shown in fig. 635; the chin-piece before

[1] For the loan of figs. 632 to 635 I am indebted to the publishers of Richardson's "Mechanical Dentistry."

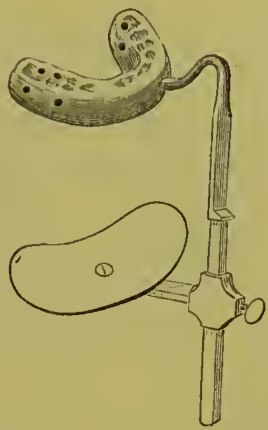

FIG. 634.

FIG. 635.

FIG. 637.—From a photograph lent by Dr. Moriarty.

FIG. 638.– From a photograph lent by Dr. Moriarty.

being applied should be padded with some soft material, such as spongiopilin.

This modification is very useful in cases where sinuses exist in the lower part of the face, as they can be treated without interfering with the action of the splint. If sinuses exist under the mandible the brass chin-piece can easily be arranged so as to permit treatment.

In some fractures, especially in the region of the molars, it is difficult at times to keep the parts in position with a Hayward splint or the modification just referred to. In such cases the form of splint shown in figs. 637, 638, and suggested by Dr. Moriarty[1] would probably prove valuable, as it exerts good pressure on the posterior fragment, which at times is difficult to obtain with the two just described. The metal chin-piece moulded to the contour of the jaw is attached to the bars of the vulcanite splint by screw bolts, which permit the amount of pressure to be adjusted to a nicety.

FIG. 639.

(γ) **The Gunning splint** (fig. 639) consists of vulcanite caps joined together by supports, and constructed to fit both the maxillary and the mandibular teeth. These caps can be filled with gutta percha as described above. When the splint is in position a four-tailed bandage is applied. The fractured jaw with this type of splint is fixed between the bandage outside and the cranium, the splint not only keeping the part in position, but also transmitting the force to the maxilla.

(δ) **The Hern splint**, a modification of the Gunning, consists of a

[1] The *Dental Cosmos*, March, 1898, p. 242.

vulcanite cap covering the teeth and alveolar border of the mandible. Blocks or pillars are built up on the upper surface of the splint, these pillars containing indentations corresponding with the upper teeth (fig. 640). In cases where the occlusion and articulation is difficult to obtain, or doubtful when obtained, the pillars or blocks are built of vulcanite so as to form shallow troughs or cavities into which gutta percha is placed for articulation with the upper teeth. The splint is applied in a similar way to the Gunning, but instead of a four-tailed bandage, Mr. Hern prefers a skull and chin cap, connecting bands between the two being arranged in a similar manner

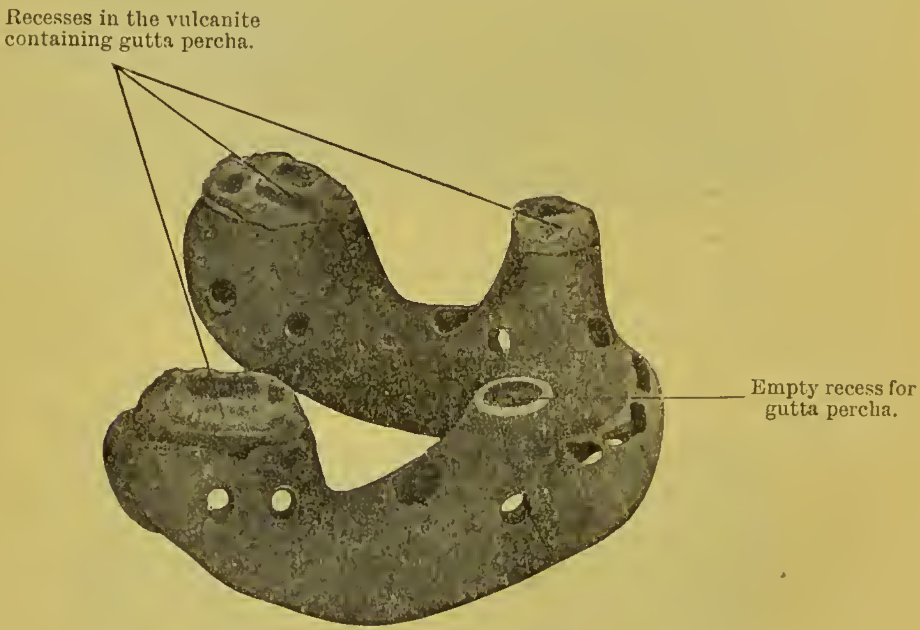

Fig. 640.

with the tails of a four-tailed bandage. The bands are made of elastic and by this means constant pressure is obtained and the tendency of the fragments to downward displacement prevented.

The advantages of this modification of the Gunning splint are :—

(1) The upper teeth are not covered, and so can be kept clean ;

(2) It can be adjusted and removed with greater facility ;

(3) It is much less cumbersome ;

(4) It allows of the adjustment of the articulation of the maxillary teeth after it has been applied, as the vulcanite surface can be cut with the dental engine, or the gutta percha in the troughs added to or removed.

In transverse fractures of the horizontal ramus in the region of the incisors, where there is little displacement, Dr. Moriarty states he has obtained excellent results from a simple splint of the character shown in fig. 641. The splint consists of a metal cap accurately filled and cemented to the teeth.

The choice of splint will depend to a great extent upon the requirements of each individual case. Where the teeth are firm and each fragment contains a few, a Hammond splint is undoubtedly best. Its advantages are :—

FIG. 641.—From a photograph lent by Dr. Moriarty.

(1) The small amount of inconvenience to the patient in the way of mechanical contrivances ;

(2) The fragments can be kept perfectly rigid ;

(3) The non-interference with speech and mastication ;

(4) The ease with which the parts can be kept clean and therefore the small risk of suppuration.

Its use is contra-indicated :—

(1) When there is much downward displacement, specially if the teeth are very short or loose, and

(2) In children, unless the deciduous teeth are firm.

The Hayward type of splint is indicated in :—

(1) Cases where there is much downward displacement and the teeth are very short or loose;

(2) Children in whom the deciduous teeth are not sufficiently firm to form a *point d'appui*;

(3) Where only a few firm teeth are present or the smaller fragment only contains one or two firm teeth.

The most suitable cases for a Hern splint are :—

(1) Those with no firm teeth in either fragment;

(2) Edentulous cases;

(3) Where the fracture is behind the last standing tooth, or in the ascending ramus.

The Gunning splint is indicated where the maxilla and mandible are fractured or where the maxilla is edentulous.

Among the **disadvantages of the Hern and Gunning splints** may be mentioned :—

(1) The closure of the mouth, interfering with speech and mastication;

(2) The dribbling away of saliva;

(3) The great fatigue from propping open the mandible; and

(4) The difficulty of keeping the mouth and splint clean.

(iii.) **Treatment by wiring.**—Suturing the fractured ends by means of wires has been advocated by several surgeons. Mr. T. S. Carter has devised some neat instruments for performing the operation, and in a communication to the *Lancet* (June 16, 1900) describes the method he adopts. It is as follows: A piece of silver-plated copper wire, No. 19, R.W.G., is taken and filed away for the distance of nearly an inch, the wire being reduced by nearly half its thickness. To make it more ductile it is passed slowly through the flame of a spirit lamp, making it a dull red for a length of about six inches. With the patient under ether the lip is drawn down, and with a sterilised bayonet-shaped drill in the motor a hole is slowly bored through the bone posterior to the fracture and between the teeth. In this position the mandibular nerve will be avoided. The hole should be drilled not less than a quarter of an inch from the fracture. While drilling with the right hand a spoon is held on the lingual side so as to guard the tongue from the drill as it emerges from the foramen. Having withdrawn the drill the plated wire is pushed through from without and, by means of forceps, drawn well into the mouth. A difficulty sometimes arises in returning the silver wire, as it is not easy to find the return passage by simply

probing for it. Having, however, drilled the hole on the other side of the fracture a pliable copper needle may be pushed through from without and bent at a suitable angle to allow of its being readily threaded with the plated suture wire. Where the point of the wire has been filed it may be bent so as to form a hook, and if the needle is then withdrawn the wire will follow.

It is well to drill the hole in the depressed fragment on a lower level than the one in the other fragment, so that there may be a lifting tendency and greater resistance to the relapse in position. The wires are then twisted until the ends of the bone are drawn tightly together. This can be accomplished by means of a specially devised

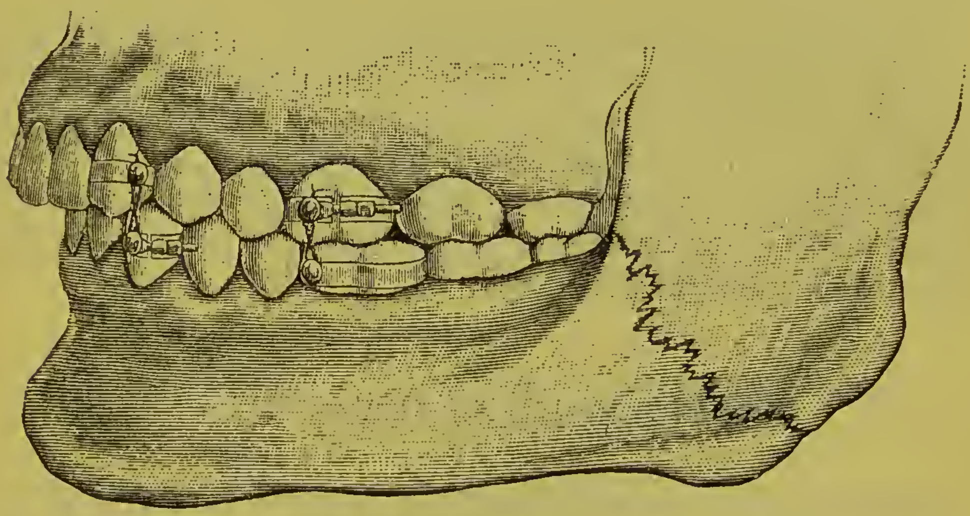

FIG. 642.—From Angle.

key. To prevent the key from cutting the wire it is necessary not to push it nearer to the bone than, say, half or three quarters of an inch before the first turn is given. Having severed the twisted wire with side cutters, an end is left projecting about half an inch long. To prevent this from cutting it is covered with a short piece of india-rubber tubing of the calibre of a crow's quill and turned down flat. Mr. Carter finds annealed silver-plated copper wire has more resistance than solid silver wire.

In the treatment of horizontal fractures involving the alveolus of two or three teeth, a cap of gutta-percha or vulcanite is quite sufficient, or the fragment may be wired to adjacent teeth. In more

severe cases a Hammond splint (or a modification of it) is perhaps the best.

Fractures about the angle may be treated with an outside gutta-percha splint made in such a way that it passes back and catches the angle. The splint can be kept in position with a four-tailed bandage, but whatever method of bandaging is used, endeavour must be made to get firm pressure over the part of the splint covering the angle, as this will assist in keeping the parts at rest by preventing the splint from shifting. It is generally found that after a period of a week it is necessary to remodel the splint. Almost invariably there is a considerable swelling about the parts, and as this subsides the splint naturally requires readjustment.

Fractures of the ascending ramus, condyle or coronoid process are best treated by merely keeping the mandible fixed. A four-tailed bandage is generally advised, but the method suggested by Angle and shown in fig. 642 seems likely to give far better results. Teeth in the maxilla and mandible are banded. To the bands studs are attached and wires passed around the upper and lower sides in a figure of eight manner.

(2) FRACTURES OF THE MAXILLA.

Fractures of the maxilla generally arise from severe violence, such as kicks from animals, gunshot wounds, &c. They are frequently comminuted, adjacent bones such as the malar and nasal being often implicated. Transverse fractures involving the **entire separation of the alveolar process from the body of the bone** have been recorded, the fracture sometimes communicating with both antra and the nasal fossæ. In a case under the care of Messrs. Ackery and Paterson[1] the fracture (caused by a severe blow on the left side of the face) commenced to the left of the infraorbital plate, and passing downwards, ended on the opposite side, about half an inch above the alveolar border. The whole maxilla could be moved *en masse* in a downward direction, and also laterally to the right, as if hinged above the alveolar border on the

[1] *Trans. Odonto. Soc.*, vol. xxii., New Series, p. 65.

right side. In a case which came under my notice the whole of the maxilla and the nasal bones seemed to have been wrenched from their attachments. The accident was caused by a lift striking the patient across the bridge of the nose.

Separation of the two halves of the maxilla in the median has been recorded. Lastly, **fracture of portions of the alveolus and of the tuberosity** occasionally occurs during the extraction of teeth.

The **complications** encountered are to a great extent, similar to those in the mandible, but the hæmorrhage is generally more severe. At times the infraorbital nerve is permanently injured.

The **treatment of fractured maxilla** does not differ in principle from that of the mandible. Teeth, unless loose, should be retained, and the same course should be pursued with fragments of bone, since the parts are so vascular that there is every chance of good repair taking place. In cases involving the alveolar plate of several teeth a Hammond is applicable. In extensive fractures similar to that recorded by Messrs. Ackery and Paterson a Gunning splint should be used. With fractures of the mandible as well as the maxilla, a Gunning splint is essential.

(B) DISLOCATION OF THE TEMPORO-MANDIBULAR ARTICULATION.

Dislocation of the temporo-mandibular articulation may be unilateral or bilateral, the latter being more common.

(1) **Causes.**—The cause of this accident may be violence, such as a blow or kick; it may arise through yawning, vomiting, shouting, or endeavouring to introduce large substances into the mouth, or during the extraction of the lower teeth, through the mandible not being supported during the operation. The unilateral variety is generally due to violence.

(2) **Morbid anatomy.**—In dislocation the condyles of the mandible slip over the eminentia articularis (fig. 613); immediately following this the masseter and internal pterygoid muscles contract, drawing the jaw forwards and upwards. The capsular ligament is stretched but is seldom torn.

(3) **Symptoms.**—In **bilateral dislocation** the mouth remains open and is rigid, so that the lips cannot be closed and the saliva dribbles away. If the region of the condyle be examined a hollow will be

felt behind the condyle and a prominence will be noticed immediately above the zygoma; according to Mr. Christopher Heath the prominence is probably due to spasmodic contraction of the temporal muscle.

In unilateral dislocation the mouth is open and fixed, a hollow being apparent behind the condyle dislocated. The chin is drawn to the side opposite to the dislocation, and this symptom distinguishes it from fracture of the neck of the condyle where the chin is drawn to the affected side. The dislocation may be overlooked and become permanent unless operative treatment is pursued.

A condition somewhat connected with the accident under consideration is "**sub-luxation.**" This was first described by Sir Astley

FIG. 643.

Cooper, and is an affection in which the patient complains of a constant clicking on opening the mouth, with occasional difficulty in the movement of the mandible. This condition, usually found in young women, was previously thought to be due to a lax condition of the ligaments, but it is now generally considered to be due to changes in the joint, the result of osteo-arthritis.

(4) **Treatment.**—Dislocation of the jaw, when quite recent, can easily be reduced by placing the thumbs on the molar teeth, the fingers being placed beneath the chin. A downward movement is to be used with the thumbs and an upward with the fingers. It is well to wrap some lint or a towel round the thumbs to prevent them being injured. If necessary the leverage can be increased by placing

corks or some similar wedge between the molars. In old standing or difficult cases ether should be given, as it will bring about muscular relaxation. After reduction a four-tailed bandage should be worn for one or two weeks, the mandible being used as little as possible. Patients accustomed to repeated dislocations should be advised to use an elastic support.

CHAPTER XXIII.

Necrosis of the Jaws.

NECROSIS affecting the jaws may be limited to a small fragment of the alveolar process, or may involve the greater part of the bone.. Necrosis is more common in the mandible than in the maxilla on account of the exposed position of the former, its smaller blood supply and the fact that it is composed mainly of compact tissue, necrosis more frequently attacking compact than cancellous tissue.

(A) CAUSES.

(1) IMMEDIATE.

The immediate cause of necrosis is interference with the blood supply to the bone. The nourishment of a bone is obtained from the vessels supplying the periosteum and the medulla, and should these supplies be interfered with by inflammatory affections, injury or new deposits, necrosis may result.

(2) EXCITING CAUSES.

(*a*) **Dental.**—**Direct injury** through fracture may cut off the supply of blood at once or set up an inflammation. Necrosis may arise from the **escape of arsenious acid** on to the gum. Arsenious acid, if left too long in the pulp chamber, may set up periodontitis apparently by the passage of the poison through the apical foramen, leading to necrosis of the tooth and the margins of the socket. In a case under the care of Mr. Schelling a maxillary molar was affected, the exfoliations from the socket fitting like three little caps over the surfaces of the roots.

The most serious examples of necrosis of dental origin are those following **septic periodontitis**. The trouble may be limited to the alveolar process or may involve the body of the bone. How severe

a condition can arise will be seen from the following case, reported by Mr. Dolamore.[1] It occurred in a little boy aged 4, and arose in the region of the left mandibular deciduous molars.

A general supporting treatment was carried out with the local use of antiseptic and deodorant mouth washes. At the end of ten months the necrosed bone was removed and the extent of the disease can be gleaned from fig. 644.

The skiagraph seen in fig. 645 shows the extent to which new bone had been formed from the periosteum and clearly demonstrates the value of a "waiting" treatment in these cases.

A case is reported by Mr. Breward Neale,[2] in which an extensive necrosis of the mandible was attributed to a dental operation.

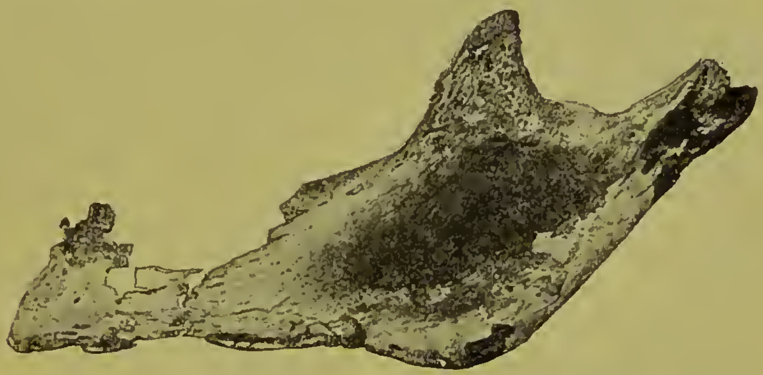

FIG. 644.—From the *Journ. Brit. Dent. Assoc.*

"The patient, a medical man, consulted a dental practitioner on account of great pain from a mandibular right canine in which the pulp was exposed. At the first visit the pulp was dressed with a devitalizing agent; at the second visit a portion of the pulp was extirpated; at the third visit the root and crown were filled, but a flexible drill was broken in the canal. The position of affairs was made clear to the patient, and he went away. On the fourth day he experienced great pain, and he attended and asked for the tooth to be removed, but as it was thought possible to save the tooth an opening was made through the alveolus with a view of relieving the pain. The patient attended the next day, again hoping to have the troublesome tooth removed, but the practitioner still thought removal

[1] *Journal of the British Dental Association*, Jan. 15, 1900.
[2] *Trans. Odonto. Soc. Great Britain*, 1900.

of the root unnecessary and excised the crown. On the sixth day, however, the root was extracted, but no relief following, the case passed into the hands of his surgical colleagues."

FIG. 645.—From the *Journ. Brit. Dent. Assoc.*

The patient then went into hospital. The pain and swelling increased and the submaxillary and submental regions became swollen and brawny. Free incisions to the bone gave little relief. The condition became very grave, the whole mandible becoming

involved as far as the angle, and the outline of the neck obliterated. The patient fortunately recovered, but at different times forty-nine sequestra were removed. The average size of the larger ones was 1 inch long, $\frac{1}{4}$ inch wide, $\frac{1}{16}$ inch thick.

(*b*) **Phosphorus.**—This form of necrosis was first described by Lorinser, of Vienna, while Dr. Wilks was the first in this country to draw attention to the subject. It is a severe form of disease and may affect both jaws, though usually one at a time.[1] It is usually at first slow in its progress. The condition is one of cario-necrosis and differs in no respect from the same lesion seen in other bones and arising from various causes.

This form of necrosis is nearly always seen in those subjected to the fumes of phosphorus. The following figures, by Professor Oliver, will give some idea of its frequency. It is computed that about 4,500 people are engaged in the United Kingdom in lucifer match making. In six years (1893 to 1898) thirty-seven cases of necrosis are known to have occurred. It is to be noted that the disease is mainly met with in those engaged in the dangerous parts of the manufacture, namely, "Mixing," "Dipping," "Drying," "Boxing."

A case has been recorded in a child aged 7, who was in the habit of playing with matches, while a very curious case is given in *L'Odontologie*: "The patient was a man of good health, but addicted to the habit of excessive cigar-smoking, consuming about twenty cigars a day and using many matches to each one, as he frequently interrupted the smoking during his work. It was computed that for the last twenty years he had daily inhaled the vapour of phosphorus given off by over 100 matches. The early symptoms were pain in the right eye, with swelling involving the whole side of the face. Suppuration supervened and the pus obtained a free flow into the oral cavity. The patient's condition grew worse and the maxilla was eventually removed. A few months later a fresh operation was necessary; but the patient collapsed, dying from meningitis. The patient's teeth were in a deplorable condition."

The late Dr. Magitôt, who carefully studied the question of phosphorus poisoning, was of the opinion that operatives exposed for a prolonged period to phosphorus fumes develop a peculiar constitutional condition which he termed *phosphorisme*. There is a general lowering of the system, inducing dyspepsia, bronchitis and

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[1] In 51 cases collected by von Bibra, 5 occurred in both jaws, 21 in the maxilla and 25 in the mandible.

allied affections. Dr. Arnaud, the medical officer in charge of the French Government Works at Marseilles, states: "that about one-half of the operatives are anæmic, especially young females from 18 years upwards; also 28 per cent. of the hands suffer from bronchitis." He, however, does not consider that work in a match factory necessarily predisposes to tubercular diseases of the lungs.

In Grammont, one of the principal seats of the industry in Belgium, the medical officer treated in twenty-five years thirty cases of spontaneous fracture of long bones caused by muscular effort. This liability to fracture of long bones is somewhat confirmed by Dr. Garman, the medical officer to Messrs. Bryant and May.

The fumes emanating from phosphorus consist principally of phosphorus anhydride (P_4O_6), and phosphoric anhydride P_2O_5). These fumes are probably dissolved in the saliva. (1) The action may be purely local, in which case the irritant finds its way through a septic pulp or wound of the bone and sets up an inflammation of the periosteum, followed by suppuration and necrosis; or (2) the phosphorus fumes produce a general lowering of the resistance of the individual, and also locally, by their irritant action, weaken the nutrition of the bone and render it more liable to attack by micro-organisms.

There is some uncertainty as to whether the phosphorus fumes act directly upon the oral tissues. In experiments conducted by von Bibra, suppuration and cario-necrosis were produced in rabbits which had been exposed to the fumes of phosphorus after teeth had been extracted and the bone fractured. It is stated by Stockman[1] that these animals when dead were found to have tubercle of the lungs. This latter observer himself exposed four rabbits in hutches to the fumes after the periosteum and gum had been removed over a considerable portion of the maxilla and mandible in each. In one a tooth was loosened in addition, the operations being all performed under chloroform. The animals seemed to suffer no inconvenience either from the operation or from living in the phosphorus-fume atmosphere. It was very difficult to prevent the gum growing over the exposed bone, and after many weeks there was not the slightest trace of any jaw affection. The exposed surface of bone became slightly eroded and rough, but whether from the action of the acid

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[1] *Brit. Med. Jour.*, 1898.

fumes or from that of the bacilli of the mouth it was impossible to decide.

Six specimens of pus from cases of phosphorus necrosis were examined by Stockman. He found staphylococcus albus, streptococci and numerous other organisms. In every case he was able by the Zeilk-Neelsen method to demonstrate the bacillus tuberculosis. Stockman considers that the condition is of a tubercular nature, the phosphorus fumes simply rendering the tissues more liable to attack by lowering their vitality.

The sequestrum from cases of this form of necrosis is peculiar, owing to a deposit known as the "pumice-stone" deposit. This is found in sequestra from the mandible, but not in those from the maxilla. It is formed from the periosteum, but is so closely adherent to the sequestrum as to be generally brought away with it. A point of interest in regard to the structure of the deposit is that the Haversian canals are larger than in normal bone; they run at right angles to the general direction of the bone, and not parallel to it; they interlace with one another, and in some places form sac-like expansions. Although this peculiar deposit is generally seen in cases of phosphorus, it may occur in other forms of necrosis.

The *symptoms* of this disease generally commence with toothache, which is at first local and constant, and later becomes more severe and erratic, the pain shooting to the side of the head and towards the shoulder. The disease is at first subacute. The gums become swollen and livid, the swelling and tenderness increase, and suppuration eventually takes place. The skin over the part becomes red, tense, and distended. Bronchial and pulmonary symptoms from irritation may develop, while later, during the advent of suppuration, there is often well-marked pyrexia, accompanied by rigors. The sufferings of the patient are much relieved by the discharge of the pus.

Prognosis.—If the disease is not too far advanced and the treatment is prompt the prognosis is favourable. About 83 per cent. attacked recover.

Treatment.—The patient must be removed to healthy surroundings. All septic teeth should be removed. Any pus which may have formed should be evacuated. The further treatment is carried out on the lines suggested on p. 641.

The prophylactic treatment is the most important. The yellow phosphorus is the dangerous allotropic form, and ought to be aban-

doned in lucifer match making. The operatives should be subjected to periodical examination by a properly qualified dental surgeon, in order that all sources of dental irritation may be removed. The surroundings of the operative should be made as healthy as possible.

(*c*) **Exanthematous fevers.**—During convalescence from exanthematous fevers necrosis of the alveolar portions of the jaws is occasionally noticed and it has usually been regarded in the light of one of the specific sequelæ which are prone to follow these fevers. So far, attention has been drawn to this question by those who have only seen the patients during convalescence and have therefore quite naturally assumed that the condition had arisen subsequent to the acute stage of the fever. Dr. Austen,[1] in an extended experience at the Western Fever Hospital, is of the opinion that necrosis always begins during the acute stage of the illness. In five thousand patients treated at the Western Fever Hospital, all of whom were under observation for at least eight weeks, the cases of necrosis that occurred could all be referred to the acute stage of the illness, not one having arisen during convalescence.

Necrosis is more common in connection with scarlet fever than measles and is rarely met with in small pox, &c.

In scarlet fever, necrosis is mainly met with in cases in which severe throat symptoms are present, and is usually first clinically recognised in the second and third week of illness. Children between the ages of 4 and 6 are the most frequent sufferers, but it may occur in younger and older patients.

Austen states that:—

"Scarlatinal necrosis of the jaw is most frequent in the lower incisor region on the labial side. It is, however, often seen in the premolar and molar regions on the buccal aspects. In the former situation it is usually symmetrical, less frequently so in the latter. In one case, under the care of a colleague, necrosis occurred on the inside of the ramus, well behind the last molar tooth, and not involving the alveolus in any way. The necrosis may involve the bone forming the sockets of the temporary teeth only, or more rarely, and especially in the lower incisor region, cause destruction of the bone enclosing the sacs of the permanent teeth.[2] The sequestrum

[1] *Dental Record*, June, 1896.

[2] The fact that so many of these cases die probably accounts for some cases of destruction of the permanent tooth sacs being overlooked.

usually takes two or three weeks to separate. The mortality of the cases in which necrosis of the jaw takes place is high, partly from the usually intrinsically severe nature of these cases, partly from aggravation of the symptoms caused by the necrosis. In the worst cases the mouth becomes horribly foul, and the patient soon dies of pyæmia or septic broncho-pneumonia. Two causes may be clinically recognised for this necrosis of the jaw in scarlet fever. Firstly, exposure of the bone by ulceration of the gum, seen in severe stomatitis, already alluded to. Secondly, and more frequently, injury. The latter cause may appear a somewhat remarkable one to anyone not acquainted clinically with this disease."

"For the efficient treatment of the very severe throat conditions present in so many cases of scarlet fever, constant applications to the fauces (of antiseptics, &c.) becomes necessary, with removal of any secretions likely to decompose or lead to injury. This is done by syringing, spraying, or swabbing, the latter procedure being most effective. These methods, however, necessitate the introduction into the mouth of bone or vulcanite syringe nozzles, spatulas to depress the tongue, occasionally a cork wrapped with lint to gag the mouth open temporarily. However great be the care employed it is almost impossible in some children to avoid injury to the temporary teeth. The child will bite the spatula or the nozzle of the feeding vessel, &c., until the teeth become quite loose and fall out, the septic state of the mouth then causing ulceration, and ultimately necrosis of some part of the socket. I have been many times surprised at the very slight pressure with a spatula, or other implement used in examining the throat, will loosen or extract the teeth in these cases, even when employed with the greatest care and gentleness. Even short of extraction of these teeth I am convinced from clinical observation that necrosis of the alveolus often arises merely from pressure on the crowns and that not undue in amount. In severe cases in which extensive necrosis appears, I am convinced that it is best to leave the fauces entirely alone, and to feed the child solely with the nasal tube, as if the treatment be persevered in the case will only go from bad to worse."

Dr. Austen's remarks have been quoted fully because they seem to throw much light upon this hitherto obscure condition. During the acute stage a piece of bone may die from either ulceration or injury, and may remain hidden beneath the gum for some time, the true condition only becoming manifest when the bone has

separated from the living bone and is being exfoliated. Exanthematous necrosis so-called, would therefore seem to be *not* a secondary specific sequel, but rather a condition taking place during the acute stage.

Symptoms.—When seen during convalescence there is a certain amount of swelling and pain, but not as a rule so marked as in some of the other varieties. The gums become stripped off from the margin of the jaw, leaving the alveolar border bare. From the margin of the gum pus oozes, and the peeling of the gum progresses in a vertical, and not in a lateral, direction, until the sequestrum becomes loosened and is easily removed. There is no thickening and no effort to form supplemental bone. The breath is generally fœtid, and there may be some rise of temperature. One side generally starts a little time after the other.

(*d*) **Mercury.**—A long course of mercury or the constant inhalation of mercurial fumes may lead to necrosis. This form of necrosis is uncommon at the present day, as mercury is not now given to the extent of producing salivation, and operatives employed in the manufacture of looking-glasses are not now subjected to the same risks as formerly. Mercury causes necrosis by setting up an acute suppurative periostitis.

(*e*) **Syphilis.**—Necrosis usually occurs in the tertiary stage, the favourite seat being the hard palate. It is usually the result of a gumma, but it may arise from an osteoplastic osteitis. The mandible is less liable to syphilitic disease than the maxilla.

(*f*) **Inflammation of the mouth.**—In severe ulcerative conditions, the disease may extend and involve the periosteum, causing necrosis. This is most frequently seen in gangrenous, less frequently in ulcerative forms of stomatitis.

(*g*) **Acute necrosis.**—Acute infection is rarely met with. A case is recorded by Mr. Roughton[1] in a boy aged 6½. The half of the mandible was involved, the disease starting in the region of a molar. A case has been reported in a baby two days old, the alveolar process of the maxilla being involved. In this case it is possible that injury occurred during labour.

(*h*) **Malignant disease.**—In the course of epithelioma and sarcoma necrosis may arise, and it is important to bear this in mind because the one condition is liable to be mistaken for the other.

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[1] *Trans. Odonto. Soc.*, vol. xxx., p. 7.

(A) SIGNS AND SYMPTOMS.

The symptoms of necrosis in the early stages simulate periostitis. The gums become much swollen and tender, and suppuration occurs, the pus discharging and leaving sinuses; the teeth become very loose and pus oozes up the sides. The skin may be shiny, red, œdematous, and the breath fœtid. In severe cases gangrene may ensue, and may quickly terminate fatally.

(B) DIAGNOSIS.

Necrosis is apt to be confounded with epithelioma of the gums which has spread to the antrum (creeping epithelioma), or it may be mistaken for sarcoma. Actinomycosis also simulates necrosis (see page 642). Dead bone can be recognised by the grating sensation produced when a probe, on being passed down a sinus, impinges upon the bone. In children the sequestrum frequently involves the permanent teeth, while in cases of phosphorus necrosis it presents a peculiar appearance known as the pumice-stone deposit, which has already been referred to. This peculiar appearance may occur in other forms of necrosis, though not so frequently as in that caused by phosphorus. After removal of the sequestrum in the maxilla the tissue of repair is usually fibrous in character, no new bone being formed, whereas in the mandible a considerable amount of new osseous tissue is formed from the periosteum, and in a notable case recorded by Mr. Savory (*Roy. Med. Chir. Soc. Trans.*, vol. lvii., pp. 187-191) the whole jaw was removed from a lad aged 18, and six months afterwards when death occurred, a new mandible had practically reformed in two pieces.

(C) TREATMENT.

In the early inflammatory stages any cause, local or general, should be removed, local depletion carried out either by scarification or leeches, and hot poppy fomentations applied. A good purge must be given, and in addition Christopher Heath recommends large doses of iodide of potassium, opium being added when there is much pain. Should destruction of the bone seem probable, free incisions must be made to relieve tension, while loose teeth should be removed. The health must be supported, and if solid food cannot be taken fluids must be given. If the bone is necrosed, but immovable, the case should be left alone for nature to throw off the sequestrum. If more than one sinus exists they

should be connected, and deodorant mouth washes prescribed. As soon as the bone is loose it must be removed with suitable instruments. When the necrosis involves large portions of the jaw surgical measures may be called for, but should not be adopted until the new bone developed from the periosteum is sufficiently complete to maintain the form of the jaw. For the method of procedure the reader is referred to one of the manuals of surgery.

ACTINOMYCOSIS.

This rare condition, when it affects the jaw, may easily be mistaken for necrosis, and it may with advantage be referred to here.

An excellent *resumé* of this disease was given by Mr. Eve at a meeting of the Odontological Society in 1888. He describes the disease when attacking the maxillary region as follows: "It often begins with severe pain, localised in one or more teeth, which are frequently carious. A swelling appears about the lower, or less commonly the upper jaw, in the cheek or near the angle of the jaw. This usually softens and suppurates, the abscesses opening at many points and giving rise to numerous intercommunicating fistulæ." The disease rapidly spreads and involves contiguous parts. Microscopic examination of the discharge will show the characteristic ray fungus, and should the disease be recognised, operative measures must be adopted.

TUBERCULOSIS OF THE ALVEOLAR PROCESS.

According to Carl Zandy,[1] tuberculosis of the alveolar process usually develops between the ages of 15 and 20, and affects males more frequently than females. The gums swell, are loosely attached and bleed readily. Ulceration follows; the teeth loosen and are lost, and a necrotic condition of the bone ensues. Zandy collected from the literature of the last twenty years thirty-seven cases of tuberculosis of the alveolar process. Carious teeth and occasionally wounds are the seats of entrance of the tubercle bacilli. A diagnosis must be made between syphilis and carcinoma.

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[1] *Arch. f. Klin. Chir.*, lii., p. 178.

CHAPTER XXIV.

Suppuration of the Antrum, Empyæma Antri.

THE chief antral disease which comes under the notice of the dental surgeon is suppuration of the antrum.

(1) CAUSES.

(*a*) **Septic infection of dental origin.**—Antral empyæma is frequently of dental origin, due to the close relationship of the roots of the teeth to the floor of the antrum.

The roots of the canines, premolars and molars may project into the antrum and be covered by membrane only. Septic periodontitis, therefore, in connection with any of these teeth may infect the antrum. The molars are the chief offenders. The fact that the third molar is closely related to this cavity is frequently overlooked, more especially by medical men. Suppuration in connection with any tooth from the central incisor to the third molar may burrow into the antrum and infect it.

In one case recorded by Mr. Kekwick[1] tubercle bacillus was present in the pus, the local tuberculosis being lighted up by a periodontitis in connection with a second premolar. Infection may arise from the passage of a septic tooth into the cavity, or from the suppuration of a dental cyst.

(*b*) **Extension of inflammation from the nasal fossa.**—The acute conditions which occur in the course of influenza and some of the exanthemata probably arise from inflammation extending from the nasal fossa.

(*c*) **Extension of infection from the frontal sinus.**

(*d*) **Injury**, such as a blow on the cheek, operations on the face, &c., &c. A case of empyæma antri in a child eight weeks old, the

[1] *Brit. Jour. Dent. Science*, May 15, 1895.

result of injury at birth, is recorded by Mr. D'Arcy Power,[1] but cases in children are rare.

Avellis[2] considers that such cases are really tuberculosis of the maxilla, as empyæma of the antrum is hardly possible at such an age, the antrum being only 5mm. deep at the fourth month of life.

(*e*) **The presence of a foreign body,** such as a piece of steel, a bullet, &c.

(*f*) **Necrosis of the maxilla,** usually syphilitic in origin.

(2) SIGNS AND SYMPTOMS.

(*a*) **Acute.**—The most typical symptoms are seen after influenza. There is a feeling of intolerable distension of the zygomatic region with pain of a throbbing character. The skin covering the bone becomes swollen, red and very sensitive. Coughing and blowing the nose accentuate the feeling of distension by increasing the tension in the antral cavity. If the ostium maxillare is patent there may be a discharge from the nose. The pain is most severe in cases where the opening is blocked, but it is at all times acute, as the inflammatory infiltration of the parts themselves produces pressure on the nerves. When the ostium is blocked an increased tension from pent-up discharge naturally increases the pain. General febrile symptoms are present.

(*b*) **Chronic.**—The symptoms are often insidious and a case may escape recognition for a long time. The **most prominent symptom is discharge from the nostril** on the affected side. A bad odour is at times noticeable by the patient himself unless his olfactory powers have been blunted by nasal disease. Pain is not often severe and is not necessarily local. The pain may be referred to the frontal region or to the teeth or may be felt over the affected antrum. The part may be tender and the patient thus unable to sleep on the affected side. There is always some thickening and capillary injection of the soft parts over the affected antrum. In chronic cases, should the ostium maxillare become blocked when the pus has filled the antrum and is exerting pressure, the symptoms become acute. It must be remembered that pus under pressure in the antrum behaves precisely in the same manner as pus under

[1] *The British Medical Journal*, Sept. 25, 1897.

[2] *Münchener Medicinische Wochenschrift*, vol. xlv., p. 45, 1898.

pressure elsewhere, *i.e.*, it finds its way out by the path of least resistance. There is no bulging of the antral walls or displacement of eyeball or alveolar process. Cases presenting symptoms which have hitherto been regarded as suppurating antra are really cases of suppurating cyst, most often dental cysts.

(3) COMPLICATIONS.

Suppuration in an antrum may lead to **necrosis** of its walls, to **infection of sphenoidal sinuses** or to **septic meningitis** through venous channels (deep facial and. pterygoid plexus). The swallowing of pus may lead to **septic gastritis.**

(4) DIAGNOSIS.

In all cases of chronic suppuration there is some thickening of soft parts over the affected antrum; slight in many cases, but always noticeable. A purulent discharge from the nose, accompanied by a dull, deep-seated pain, is always suggestive of antral suppuration. Empyæma antri must always be diagnosed from ozœna; in the latter the breath is offensive to bystanders, but not to the patient, while the contrary is the case in suppuration of the antrum. The presence of septic teeth in the molar or premolar region would assist in the diagnosis. Pain in the frontal region of one side (supra-orbital nerve) should always arouse suspicion of antral disease of that side; this pain is in some cases severe, even in chronic antral disease.

To positively determine the presence of pus there are several methods :—

(*a*) Cleanse the nasal cavity, **make the patient assume a position so as to bring the ostium lowest.** If the ostium is patent pus will trickle from the nostril. With a nasal speculum pus may be seen in the middle meatus.

(*b*) The **antrum may be punctured** by a trocar and canula through the canine fossa or nose, and washed out through the canula so inserted.

(*c*) **Transillumination.**—For this purpose the patient is placed in a totally dark room and an electric lamp placed in the mouth. The two sides are then compared.

Note :—

(i.) Whether the pupils are equally illuminated from within.

(ii.) Whether the patient appreciates light equally on both sides (patients can usually answer the question intelligently).

(iii.) The amount of light visible around the lower edges of the orbits.

(iv.) The amount of light passing through the cheeks. This is always lessened by an ordinary swollen face; solid growths also arrest light.

The possibility of double antral suppuration must not be overlooked.

(5) TREATMENT.

(*a*) **Acute.**—The treatment of suppuration in the antrum is to give free vent to the pus, and thoroughly drain the cavity in the same way as in the case of suppuration in other parts. For giving vent to the pus it will be needful to "tap" the antrum at some point. If carious teeth are present they should be removed and the antrum perforated through the socket of the extracted tooth; when possible the anterior buccal root of the first molar should be chosen, because this root opens into the antrum more frequently than any other. When the teeth are sound and living the canine fossa is the best situation for opening into the antrum. To perform the operation a bone-shaped bur fitted in a socket handle should be used, a small bur being used first, followed by a larger one. It is important to have a good sized opening. The bur should be held somewhat like an elevator, the first finger acting as a stop. By adopting a steady rotatory motion the danger of penetrating through the floor of the orbit will be avoided. An opening having been obtained the cavity must be well syringed with some antiseptic, and if the disease is acute the cavity must be allowed to drain to permit of its being carefully syringed. This should be done twice a day at first, and subsequently once a day. **Acute cases usually get well.**

(*b*) **Chronic.** These cases are difficult to treat and often drag on for years. Mr. Turner,[1] who has paid a good deal of attention to this subject, points out that there are three main difficulties in treatment:—

[1] *Trans. Odonto. Soc.*, vol. xxxii., p. 118.

(i.) The cavities into which the antrum must be made to drain, namely, the nose and mouth, are not usually surgically clean.

(ii.) The mucous membrane is considerably thickened and at times polypoid.

(iii.) The nature of the antrum itself.

(α) The cellular character of the upper part around the ostium.

(β) The ease of communication with the frontal sinus by which an antrum may be infected from that cavity.

(γ) The possibility of infection from the ethmoidal sinuses.

A proportion of chronic cases get well under no more severe treatment than drilling up through the socket of a tooth, inserting a small unplugged silver drainage tube, and syringing with warm boracic lotion (10 grains to the ounce of boiled water) twice a day. Cases said to have been of five years' standing have been cured in this way. Many, however, refuse to yield to such treatment. The most thorough and efficacious treatment in such cases is to make a large opening from the outer surface, scrape out the cavity and then open well into the nose along the inferior meatus. Mr. Turner suggests the following plan: First, render the nose and mouth as clear as possible at the time of operating; make a horizontal incision about $1\frac{1}{2}$ in. long at the level of the apices of the roots of the teeth; reflect the muco-periosteum to bare the bone; chisel away the outer wall of the antrum back to the base of the malar bone and forward to the anterior angle of the antrum. Bone nibblers will be found very useful to supplement the chisel. Having then a good view of the cavity, scrape the walls well and explore the recesses of the upper and inner part in the region of the ostium for cellular recesses; these may be swabbed out at once with pure carbolic acid if bleeding can be sufficiently restrained, or within the next few days. Acting on the knowledge thus gained, chisel away the inner (nasal) wall of the antrum from before well back to the further end of the antrum, leaving a pillar of bone in front to support the nostril, and from below, at the level of the floor of the nose, upwards to the insertion of the inferior turbinate bone. The cavity need not be packed, but should be syringed twice or three times a day so long as discharge continues. After the first few days the mouth opening should be allowed to close, and a nozzle with a short curved end, introduced through the nose, should be used for syringing.

The discharge may continue for some weeks after the operation

Venous bleeding is the chief difficulty of the operation, and may require frequent stops to allow of its control by pressure. To minimise swallowing of blood and the danger of blood passing down the trachea, the post-nasal space may be packed by passing into it a lint roll secured by a tape. The surgeon should work as much as possible with the head turned to one side. Sponge holders which fasten with clips ike artery forceps are the only safe ones to use for swabbing out the throat.

CHAPTER XXV.

Interference with the movements of the Temporo-Mandibular Articulation (closure of the jaws).

In practice cases of closure of the jaws are frequently met with, and the treatment of some of them falls within the province of the dental surgeon, while others belong to the domain of general surgery. It is therefore needful that the dental student should be able to diagnose such cases, and, if necessary, to treat them.

(A) **Causes.**—The causes producing interference with the movements of the temporo-mandibular articulation are :—

(1) Infiltration of the soft tissues with inflammatory products, frequently seen in trouble from the mandibular third molars.

(2) Spasms of the muscles closing the jaw.

(3) Diseases of the temporo-mandibular articulation.

(*a*) Arthritis, acute or chronic.

(*b*) Osteo-arthritis.

(*c*) Anchylosis, osseous or fibrous.

(*d*) Hypertrophy of the condyle.

(4) Cicatricial bands stretching between the maxilla and the mandible, the result of previous ulceration.

(5) The presence of tumours external to the jaws.

(6) Exostosis of the zygomatic arch, preventing free movement of the coronoid process.

(7) Ossification of the pterygo-maxillary ligament.

(8) Presence of a deep-seated growth.

(9 Tetanus.

(10) Strychnine poisoning.

(B) **Diagnosis.**—The larger number of cases coming under the care of the dental surgeon arise from the first cause, and it is

therefore best to eliminate these first in proceeding with the diagnosis.

When the closure is **due to inflammatory effusion** into the soft tissues, the patient's face will be found swollen, hot and tender, although the mouth can usually be opened to a slight extent. Upon examining the teeth it will generally be found that inflammatory trouble and suppuration exist around the third molar, sometimes the second, less frequently the first. The commonest cause of this condition is difficult eruption of the third molar.

Closure of the jaws **due to spasm of the masseter and other muscles** is very rare, and when it does occur is generally due to irritation from an erupting third molar, although trismus may also be caused by irritation of the pulps in the second and first molar. The tonic spasm, which causes this variety of "closure," may come on quickly or slowly. There will be an absence. to a great extent, of inflammation, and entire loss of power to open the mouth.

Inability to open the mouth without great pain is a symptom of both **acute and chronic arthritis** of the articulation. The diagnosis from this cause will not be difficult, as the patient will not only complain of pain on attempting to move the joint, but will also complain of tenderness over the region of the joint; and on examination the parts will be found swollen and tender to the touch.

Osteo-arthritis only leads in its early stages to stiffness of the jaw which is felt more in the morning, the patient complaining that there is slight difficulty and pain in eating his breakfast. On opening the mouth a clicking sound is audible, not only to the patient but also to the surgeon. The stiffness of the jaw increases until in the most advanced cases the articulation becomes practically fixed owing to alterations in the shapes of the articular surfaces which are a phenomenon of this disease. Osteo-arthritis may be suspected when a patient of forty years or upwards gives a history of gradual loss of power to open the mouth. On examining the region of the joint a hard swelling will be felt which may be unilateral or bilateral according to whether one or both sides are affected. The mandible will be seen to have slight mobility, and on feeling over the region of the joint a sensation of grating may be felt.

Osseous or fibrous anchylosis may be suspected when the patient gives a history of previous injury or inflammation in the joint. On examination it will be found that the immobility is complete in the

osseous anchylosis while in the fibrous a slight movement can be obtained.

Hypertrophy of the condyle.—In this condition the side of the face on which the hypertrophy exists appears swollen over the region of the articulation. The chin is pushed to the opposite side and the face distorted on the affected side. The movements of the jaw are restricted.

Cicatricial bands stretching between the maxilla and the mandible are a common cause of closure of the jaws. The patient generally gives a history of previous ulceration, either of a strumous or syphilitic origin, or arising from some form of stomatitis, the ulceration being followed by formation of cicatricial tissue. This form of closure may occur at any time of life and continue unless treated. Examination of the mouth will show a band of fibrous tissue stretching vertically between the jaws.

Exostosis of the zygomatic arch and ossification of the pterygo-maxillary ligament are very rare. In the former condition an examination of the zygomatic arch at once makes the condition plain; and in the latter a stiff band is felt in the region of the pterygo-mandibular ligament. Patients affected by these forms of trismus are as a rule of a gouty or rheumatic diathesis.

Tumours pressing upon the jaw from without may occur in the parotid or sub-maxillary regions, or in the situation of the deep cervical glands along the border of the sterno-mastoid muscle. A swollen lymphatic gland over the masseter muscle due to septic absorption from the mouth is a frequent cause of stiff-jaw. The diagnosis from this cause will present no difficulty.

Deep-seated malignant tumours may lead to interference with the mobility of the jaw. Cases of this character are recorded by Coleman, Tomes and others. This condition may be suspected when, after careful examination, other causes of immobility of the jaw can be eliminated.

Tetanus and strychnine poisoning each lead to trismus. They are less frequently met with than other causes, and are recognised by the presence of the symptoms of a general character to which they give rise.

The diagnosis of the causes giving rise to closure of the jaws is best carried out by one of exclusion, and in doing this the more frequent cause should be considered first. They may be taken in the following order: suppuration around, and irritation from, the

molar teeth; the presence of cicatricial bands; arthritis; anchylosis; hypertrophy of the condyle; growths pressing from without; and lastly, such rare conditions as exostosis of the zygomatic arch and tetanus.

(c) Treatment.—If of dental origin an anæsthetic should be administered, the mouth forcibly opened, and the offending tooth or teeth removed. Some little difficulty may be met with in opening the mouth. For most cases a Mason's mouth-gag is generally quite sufficient, but when the degree of trismus precludes the use of this instrument in the first place, the mouth can usually be forced open by a graduated wedge or spiral cone of box-wood. Instruments for forcibly opening the mouth must be employed with great care. Following the extraction of the tooth, poppy-head fomentation should be advised. The time of complete recovery of the free movement of the jaw will depend very much upon the severity of the case. When it is not practicable to remove the third molar, relief may be given by extracting the second. If the trismus is due to acute arthritis, wedges should be placed between the molar teeth and a four-tailed bandage applied, as by this means the articulating surfaces will be separated, and so relieved from pressure. Over the region of the condyle an application of the tincture or liniment of iodine should be made, and purgatives administered.

In osteo-arthritis the treatment in the early stages must be constitutional rather than local. The patient should be advised to avoid as far as possible exposure to the weather. To those whose occupation causes them to be much in the open air a cap with folds to tie over the region of the joint is to be recommended. Some relief may be obtained by careful massage of the joint and by rubbing in sulphur ointment over the affected region, sulphur and guaiacum being at the same time given internally. In the more advanced stages, when the jaw has become more or less anchylosed, the operation of excision of the condyle or section through some part of the ramus may be practised.

Osseous and fibrous anchylosis require for treatment the formation of a new joint; while for hypertrophy of the condyle excision of the joint may be necessary. Cicatricial bands can be treated by division of the cicatrices or the formation of a new joint, the latter being now generally adopted. Exostosis of the zygomatic arch and ossification of the pterygo-maxillary ligament would, if met with, be best treated by the formation of a new joint. If the trismus

is due to external swelling, the treatment will consist in seeking for and, if possible, removing the cause of the swelling.

The operations devised for the relief of stiff-jaw are:—(1) Excision of the condyle. (2) Esmarch's operation. This is performed by making an incision about two inches in length along the lower border of the body of the jaw, and then, by means of a saw, removing the wedge-shaped piece, the base of the wedge being below. In one case recorded by Heath the base measured half an inch, the apex a quarter, while in another which he records the base was seven-eighths of an inch.

For further details regarding these operations, see Heath's "Injuries and Diseases of the Jaw," Fourth Edition.

CHAPTER XXVI.

Some Common Affections of the Tongue met with in the Course of Dental Practice.

Certain diseases of the tongue, more especially epithelioma, may come under the notice of the dental practitioner before their presence is recognised by the patient. Their early recognition is most important.

(A) **Chronic superficial glossitis** is a disease very insidious in its onset. It is a chronic inflammation of the mucous membrane of the tongue, the commencement of the trouble being situated in the papillæ. In the earliest stages the papillæ are in a condition of hyperæmia, but as the disease progresses, an excessive growth of the epithelium takes place. The superficial layer of the epithelium becomes opaque, and by the coalescence of neighbouring spots, whitish patches are formed upon the surface of the tongue, the organ appearing as if milk had been thrown upon its surface. Atrophy of the papillæ next takes place, so that the surface becomes smooth and still whitish in colour. Cracks and fissures may now appear and superficial ulcerations form, the disease in many cases degenerating into epithelioma. The affection, in its early stages, does not cause much discomfort, and is therefore seldom recognised by the patient. In the later stages, however, pain becomes a prominent symptom. The disease is very much more prevalent in men than women, and has as predisposing causes excessive smoking or spirit drinking, and syphilis. A large proportion of the cases end in epithelioma, and it is therefore important that the condition should be recognised and treated at an early stage.

(B) **Ulcerations of the tongue.**—The ulcers of the tongue may be divided into:—

(1) Simple irritable

(2) Dyspeptic.

(3) Epitheliomatous.
(4) Syphilitic—(*a*) Superficial.
,, (*b*) Deep.
(5) Tuberculous.
(6) Rodent.

(1) **The simple irritable ulcer** generally occurs in the region of the premolars, the cause being a sharp edge of tooth, salivary calculus, &c. In some cases the ulceration is quite superficial, but, nevertheless, very painful, both on speaking and eating. The surface is usually surrounded by a zone of inflammation. In other cases the ulcer extends deeper, the edges being irregular and abrupt, the surrounding mucous membrane inflamed, and the floor of the ulcer bathed with pus. The base, however, is not indurated, and this differentiates it from epithelioma.

Treatment consists in removing the cause.

(2) **Dyspeptic ulceration** is more frequently met with near the tip of the tongue on the dorsal aspect. The ulcers are generally multiple and superficial, the portion of tongue around them being nearly always slightly inflamed, while symptoms of dyspepsia are present. The **treatment** consists in attending to the dyspepsia, employing chlorate of potash mouth washes and, if the ulceration is very severe, brushing the surface of the ulcers with nitrate of silver.

(3) **Epitheliomatous ulceration** of the tongue being of a malignant nature, its early recognition is extremely important. It may arise from—(*a*) Neglected irritable ulcers; (*b*) old syphilitic cracks and chronic fissures; (*c*) chronic superficial glossitis. It commonly commences as a flattened warty growth, which breaks down into an ulcer and spreads rapidly. The characteristics of an epitheliomatous ulcer are as follows:—(*a*) Raised, sinuous, hard and everted edges; (*b*) the surrounding mucous membrane indurated; (*c*) the floor irregular, and covered with a foul discharge; (*d*) the base indurated, and in the latter stages the tongue fixed; (*e*) a darting pain; (*f*) profuse salivation; (*g*) enlargement of the neighbouring lymphatic glands (not in the early stages); (*h*) interference with speech and mastication; (*i*) the disease is more prevalent in men than in women; (*j*) occurs generally in those past the age of forty; (*k*) usually situated on the side of the tongue.

Treatment is excision of a portion or the whole of the tongue.

As before stated, early recognition is of the utmost importance. The presence of a wart on the side, tip, or, indeed, any part of the

tongue should always be regarded with suspicion, and the patient *at once* advised to seek skilled assistance. All ulcers of long-standing should be submitted to a careful examination. The particular points to which attention should be directed are :—(*a*) the history of the ulcer ; (*b*) the character of the edges ; (*c*) the condition of the surrounding mucous membrane. Ulceration in patients over forty is always serious, and in doubtful cases it is better to have the suspicious portion excised.

(4) **Syphilitic ulceration** of the superficial variety occurs about the sides, tip and under surface of the tongue. The ulcer may be widespread, presenting crescentic-shaped edges which are sharply cut, or the ulceration may extend in cracks and fissures, causing scarring of the tongue upon healing.

When syphilitic ulceration is due to a breaking down of a gummata the ulcer formed is typical. (*a*) The edges are sharply cut ; (*b*) the surrounding tissue is free from induration ; (*c*) the floor may present a wet-wash-leather-like appearance ; (*d*) the situation of the ulceration is usually the dorsum of the tongue in the median line ; (*e*) the tongue is movable ; (*f*) speech is not interfered with ; (*g*) the submaxillary lymphatic glands are not enlarged, but indurated glands in other parts of the body may be found ; (*h*) profuse salivation is not present ; (*i*) there is little or no pain.

The treatment consists in the administration of anti-syphilitic remedies.

(5) **Tubercular ulcers** occur on the dorsum of the tongue near the tip, in the same situation as dyspeptic ulcers. The patients in whom tubercular ulceration occurs are usually in advanced stages of phthisis. The disease starts as a small white spot which breaks down and extends. Around this more spots appear which, in turn, break down and coalesce, giving rise to a large irregular ulcer with an uneven surface covered with a yellowish discharge. The coincidence of the disease with well-marked symptoms of tuberculosis, are sufficient to prevent it being mistaken for either syphilis or epithelioma.

(6) **Rodent ulceration** is extremely rare, and scarcely needs description here.

CHAPTER XXVII.

Diagnosis of Swellings about the Jaws.

THE diagnosis of swellings in the regions of the jaws is not always an easy task. In all cases two points have to be determined:—

(1) Whether the swelling is fluid or solid.

(2) Whether it is innocent or malignant.

For convenience of description the subject will be considered under the following heads:—

(A) Swellings involving the antrum.

(B) Swellings in the palate.

(C) Swellings in connection with the mandible.

(A) SWELLINGS INVOLVING THE ANTRUM.

Fluid collections in the antrum give rise to slow but painless distension of the walls, the thinner or facial wall giving way before the more resistant; the bulging on the face is therefore one of the most prominent symptoms. The swelling itself is smooth and globular, and on pressure may give rise to the sensation known as "parchment-like crackling." The alveolar border is not as a rule interfered with, while in some instances the patient may be cognisant of the sensation of fluid in the antrum.

With **innocent solid tumours** the thicker walls of the antrum are affected equally with the thinner, the alveolar border being displaced downwards. The displacement (of the alveolar border) is generally quite regular, the teeth still maintaining an even line although arched downwards. Epiphora (overflow of tears) may be caused through pressure on the nasal duct, and severe neuralgia through pressure on the infra-orbital and anterior dental nerves.

Malignant tumours generally affect one surface of the antrum

more than the other. The alveolar border and the teeth are generally displaced in an irregular manner. The nasal fossa is early involved and there is a history of quick growth, with probably frequent attacks of hæmorrhage, severe pain, early implication of the skin, well-marked emaciation, œdema of the face, and probably enlargement of the lymphatic glands.

By observing the symptoms as above described it is often possible to determine if a tumour is of a fluid or solid character. **A fluid swelling may be** either a dental cyst, a follicular or epithelial odontome, or cystic degeneration of the mucous follicles of the antrum. The teeth should be carefully examined, and if septic teeth are present the probability is that the swelling is a dental cyst.

Absence of inflammation and slow but steady growth of the swelling point to the presence of a dental cyst. If no septic teeth are present it is probable that the swelling is either a follicular odontome or an epithelial odontome. The diagnosis between these may be made by observing whether there is an absence of a tooth or teeth from the series. If one tooth is absent and the swelling is globular in outline a follicular odontome may be suspected. On the other hand, if the swelling is lobulated and teeth are present, there is a possibility of the growth being an epithelial odontome. Cystic degeneration of the mucous follicles of the antrum may be suspected if all the teeth are present and healthy.

The solid innocent tumours occurring in the antrum are: (1) Fibroma; (2) enchondroma; (3) osteoma; (4) myxoma. The differential diagnosis of these is at times far from easy, more especially in the early stages, as they all give rise to distension of the walls of the antrum. Osseous growths are generally of exceedingly slow development, while fibromata and enchondromata may grow at times with great rapidity.

The malignant tumours occurring in the antrum are: (1) Carcinomata, (2) sarcomata. The differential diagnosis between carcinoma and sarcoma can be made by considering the age of the patient; growths in the young are always sarcomata, while those occurring in persons over the age of forty may be either sarcoma or carcinoma. A tendency to hæmorrhage will indicate a sarcoma; and growths springing from the region of the malar bone are nearly always sarcomatous. In the case of malignant tumours, a diagnosis should always be made from necrosis, especially when there is a

large amount of inflammatory material and sloughing of the soft tissue. In doubtful cases a microscopic examination of a portion of the diseased tissue should be made before performing an operation.

(B) SWELLINGS INVOLVING THE PALATE.

In previous chapters the different tumours affecting the gums have been dealt with, so that here it is only necessary to deal with those swellings which are met with in the palate. These may be divided into fluid and solid.

The **fluid** are :—

(1) Acute abscess.
(2) Chronic abscess.
(3) Dental cyst.
(4) Follicular odontome.

The **commoner solid growths** are :—

(1) Fibroma.
(2) Circumscribed osteoma.
(3) Sarcoma.
(4) Epithelioma.

In diagnosing between these the fluid must first be separated from the solid by observing whether fluctuation is present, and by the character of the swelling, whether regular, smooth and globular, or irregular and nodulated.

The differential diagnosis between the fluid tumours lies between chronic abscess, dental cyst, follicular odontome and epithelial odontome. The teeth should be carefully examined, and if septic teeth are present the probability is that the swelling is either a dental cyst or a chronic abscess.

The differentiation between these two will be assisted by :—

(1) Ascertaining the presence or absence of inflammation around the carious teeth and surrounding parts.

(2) The history of the swelling.

If inflammation is present it will point to a chronic abscess, and the same will be the case if the patient states that the swelling varies in size, or that it came quickly and has remained practically stationary.

Absence of inflammation and slow but steady growth of the swelling point to the presence of a dental cyst. If no septic teeth are present the growth is probably either a follicular or epithelial odontome.

As regards solid tumours, it must first be ascertained whether the growth is innocent or malignant by questioning the patient as to the rate of the growth, &c. If innocent the difference between a fibroma and circumscribed osteoma can be ascertained by feeling the consistency of the growth, a fibroma having a putty-like feel, while an osseous growth is quite hard. Sarcoma and epithelioma, when forming distinct tumours, will be difficult to differentiate. The epithelioma has, however, a greater tendency to ulcerate, the sarcoma to bleed.

(C) SWELLINGS INVOLVING THE MANDIBLE.

With swellings in the neighbourhood of the mandible the first step is **to determine whether or not the swelling is in connection with the mandible**, and if so, whether it involves the substance of the bone or is only connected with it externally. Taking the latter class first, the first point is to distinguish between a fluid and a solid tumour by the presence or absence of fluctuation. If the swelling is a fluid collection a differential diagnosis must be made between chronic abscess, dental cyst, follicular and epithelial odontome, by paying attention to the same points referred to in differentiating the various fluid collections in the antrum and in the palate. If the growth is solid the innocent must first be diagnosed from the malignant. The usual innocent tumours in this situation are fibroma, enchondroma, and circumscribed osteoma. The position of the growth will be of some assistance, as the usual sites of the osteoma are the angle of the jaw, inner side of the horizontal ramus in the region of the canine, and near the mental foramen.

Tumours involving the body of the bone will require rather more care in diagnosis. The principal symptom will be gradual expansion of the two plates of the mandible, the outer generally yielding to a greater extent than the inner. Fluid swellings may be suspected when the bulging of the walls is quite smooth and globular in character; the outer plate may become so thin that on pressure upon it the sensation of "parchment-like crackling" may be felt. If the swelling is fluid a diagnosis will have to be made between chronic abscess, dental cyst, follicular odontome and epithelial odontome. The mode of diagnosis between these has already been mentioned. An epithelial odontome is likely to be mistaken for a medullary sarcoma, and the diagnosis between the two is

often very difficult, but with the former there will nearly always be an absence of a tooth or teeth from the series.

With solid growths the character of the expansion of the bone is not so regular as in fluid collections, the inner plate being involved as well as the outer. With innocent growths the swelling will be of long duration, while with malignant the swelling is generally nodulated and always of quick growth. The innocent tumours may be either fibrous, cartilaginous, or osseous ; the malignant either epithelioma or sarcoma. The usual form of sarcoma is the myeloid, and its diagnosis from epithelial odontome has already been considered. Necrosis must be carefully diagnosed from malignant disease, and the likelihood of mistaking a calcified odontome for more serious mischief must not be forgotten.

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